RECOVERY FROM A CHEMICAL WEAPONS ACCIDENT OR INCIDENT: A CONCEPT PAPER ON PLANNING

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FOREWORD

Developments in the Chemical Stockpile Emergency Preparedness Program (CSEPP) are progressing rapidly. Although we have attempted to provide information that is accurate as of the date of publication, we expect that as a result of the dynamism of the program, many changes will occur in areas discussed in this report.

It should be noted that this report, which has been developed under the CSEPP, is a concept paper and is not intended as a complete technical plan. This individual report is one of a number of documents under development for the CSEPP that will address issues and provide information for recovery, reentry, and restoration in the event of a chemical agent accident or incident.

ACKNOWLEDGMENTS

This report was developed mainly under the auspices of the former Reentry/ Restoration Subcommittee of the Chemical Stockpile Emergency Preparedness Program (CSEPP) Joint Steering Committee prior to the recent restructuring of the CSEPP. The authors wish to express their appreciation for the contributions made to this report by members of the Reentry/Restoration Subcommittee.

NOTATION

ACAMS	automated continuous air monitoring system
AEC	Army Environmental Center
AEL	allowable exposure level
AMC	U.S. Army Materiel Command
AMC-R	Army Materiel Command Regulation
ANL	Argonne National Laboratory
AR	Army regulation
ARAR	applicable or relevant and appropriate requirement
ASD (P&L)	Assistant Secretary of Defense for Production and Logistics
CAI	chemical accident or incident
CAIRA	Chemical Accident or Incident Response and Assistance
CAM	chemical agent monitor
CAS	Chemical Abstract Service
CDC	Centers for Disease Control
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act (Superfund)
CFR	Code of Federal Regulations
CHEMTREC	Chemical Transportation Emergency Center
COE	U.S. Army Corps of Engineers
CSDP	Chemical Stockpile Disposal Program
CSEPP	Chemical Stockpile Emergency Preparedness Program
DA	Department of the Army
DAAMS	Depot Area Air Monitoring System
DDT	dichlorodiphenyltrichloroethane
DERP	Defense Environmental Restoration Program
DESCOM	U.S. Army Depot Systems Command
DOD	U.S. Department of Defense
DOI	U.S. Department of the Interior
DRMO	Defense Resource Management Office
DS	decontaminating solution
EE/CA	engineering evaluation/cost analysis
EIS	environmental impact statement
EMIS	Emergency Management Information System
EPA	U.S. Environmental Protection Agency
FDR(s)	foliar dislodgeable residue(s)
FEMA	Federal Emergency Management Agency
FFA	Federal Facility Agreement
FM	field manual
FPEIS	final programmatic environmental impact statement
FR	Federal Register
FTS	Federal Telephone System

GA	Tabun, $C_5H_{11}N_2O_2P$ (a nonpersistent organophosphate nerve agent)
GAO	General Accounting Office
GB	Sarin, $C_4H_{10}FO_2P$ (a nonpersistent nerve agent)
GD	Soman, $C_7H_{16}FO_2P$ (a nerve agent)
H	sulfur mustard, $C_4H_8Cl_2S$ (a blister agent)
HD	distilled sulfur mustard, $C_4H_8Cl_2S$ (a blister agent)
HMIX	Hazardous Materials Information Exchange
HRS	Hazard Ranking System
HT	sulfur mustard-T ($C_8H_{16}Cl_2OS_2$ mixture) (a blister agent)
HTH	high-test hypochlorite
IAEA	International Atomic Energy Agency
I,L&E	Installations, Logistics, and Environment (U.S. Army)
L	lewisite, dichloro(2-chlorovinyl) arsine, ($C_2H_2AsCl_3$) (a blister agent)
NCP	National Contingency Plan
NEPA	National Environmental Policy Act
NIOSH	National Institute of Occupational Safety and Health
NOAEL	no observed adverse effect level
NPL	National Priorities List
OASA (I,L&E)	Office of the Assistant Secretary of the Army for Installations, Logistics, and the Environment
OHM-TADS	Oil and Hazardous Materials Technical Assistance Data System
OP	organophosphorus
ORNL	Oak Ridge National Laboratory
OSHA	U.S. Occupational Safety and Health Administration
PAZ	protective action zone
P.L.	Public Law
QA	quality assurance
QC	quality control
RA	remedial action
RCRA	Resource Conservation and Recovery Act
RI	remedial investigation
RI/FS	remedial investigation/feasibility study
RIMS	Regional Input-Output Modeling System
ROD	record of decision
SARA	Superfund Amendment and Reauthorization Act
SI	site inspection
SIPRI	Stockholm International Peace Research Institute
SRFX	Service Response Force Exercise
STB	Super Tropical Bleach

T	$C_8H_{16}Cl_2OS_2$, component of HT (a blister agent)
TM	technical manual
USAEC	U.S. Army Environmental Center
USAEHA	U.S. Army Environmental Hygiene Agency
USC	United States Code
USNRC	U.S. Nuclear Regulatory Commission
VX	$C_{11}H_{26}NO_2PS$ (a persistent nerve agent)

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ABSTRACT

Emergency planning for an unintended release of chemical agent from the nation's chemical weapons stockpile should include preparation for the period following implementation of immediate emergency response. That period — the recovery, reentry, and restoration stage — is the subject of this report. The report provides an overview of the role of recovery, reentry, and restoration planning in the Chemical Stockpile Emergency Preparedness Program (CSEPP), describes the transition from immediate emergency response to restoration, and analyzes the legal framework that would govern restoration activities. Social, economic, and administrative issues, as well as technical ones, need to be considered in the planning effort. Because of possible jurisdictional conflicts, appropriate federal, state, and local agencies need to be included in a coordinated planning process. Advance consideration should be given to the pertinent (and, in some cases, perhaps conflicting) federal and state statutes and regulations. On the federal level, the principal statutes and regulations to be considered are those associated with the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA); the Resource Conservation and Recovery Act (RCRA); and the National Environmental Policy Act (NEPA). This report recommends that extensive preaccident planning be undertaken for the recovery, reentry, and restoration stage and outlines several key issues that should be considered in that planning. The need for interagency cooperation and coordination at all levels of the planning process is emphasized.

SUMMARY

Recovery, reentry, and restoration planning is an integral part of the Chemical Stockpile Emergency Preparedness Program (CSEPP). Established by a federal statute, the CSEPP has developed into a comprehensive program of improving the extent of plans and preparedness both for the chemical weapons disposal program and for storage of chemical agents.

Although the dominant risk to the public early in a chemical accident or incident (CAI) is from inhalation exposure, this risk changes after the release has ended. While some types of chemical agent disperse rapidly, environmental contamination by persistent chemical agents is a potential threat to humans through the ingestion pathway and through dermal (skin) exposure. Consequently, plans should be developed to implement cleanup or other controls that may become necessary during a longer period after the immediate threat has ended.

The cleanup, or remedial action, following a chemical agent accident would be regulated by a complex web of federal and state laws. While the Department of the Army would possess the greatest legal authority to manage this process, states and other federal agencies also could invoke their authority to determine the extent of the cleanup, as well as to require restoration of damaged natural resources for which they may be independently responsible. The potential for conflict that these overlapping statutes create makes it desirable to consider developing a model memorandum of understanding to integrate the different responsibilities assigned to these various agencies.

Literature on and experience with restoration planning suggest that a restoration strategy should contain a number of discrete elements, among them both technical and social components. Technical components include a sampling and monitoring plan, provision for protection of various personnel, plans for both access control and reentry into previously contaminated areas, restrictions to protect the ingestion pathway, and means of decontamination. Development of various agent measurement techniques, adoption of allowable exposure levels, and the conduct of baseline surveys are prerequisites to successful development of these elements.

Appropriate attention to the social aspects of restoration planning can reduce impacts to the affected communities. The social components of restoration planning include relocation resources, medical and psychological services, public awareness programs, information systems, and an understanding of the economic consequences of the accident. Here, the experience of other natural and technological disasters has direct application to a chemical agent accident.

Progress is being made in reentry, restoration, and recovery planning for the CSEPP, and appropriate planning appears achievable. While additional research and other developments are needed in several important areas, the basic elements of planning have been defined. Further development of these elements into formal plans will enhance the level of public protection that can be provided in case of accidental release of a chemical agent.

1 INTRODUCTION

Adequate planning for actions that will be taken in the event of a chemical agent accident or incident (CAI) is essential. Not only must on-site and off-site planning be in place for the initial emergency phase of an accident resulting in the release of chemical agents, but also for the period after the accident is brought under control, the release has been terminated, and escaped chemical agents have dispersed. Thus, planning for recovery, reentry, and restoration from an accident of this nature is an important component of the Chemical Stockpile Emergency Preparedness Program (CSEPP).

A first step in recovery, reentry, and restoration planning and preparedness is to acquire an understanding of concepts, principles, and techniques appropriate to this distinct accident phase. The purpose of this report is to take that step. Accordingly, this report provides an overview of several relevant topics that must be considered in initiating this "late-stage" emergency planning.

The terms recovery, reentry, and restoration often are used to describe the various emergency activities that follow the end of the period during which immediate protective actions are implemented. Simplified definitions of these terms, as they are used here, are provided below.*

Recovery — Recovery would occur during the period following response when the immediate threat to human life has passed and general evacuation has ceased. Recovery refers to the actions taken to restore an affected area as nearly as possible to its preemergency condition. Thus, it refers to the process of reducing exposure rates and concentrations in the environment to acceptable levels for unconditional occupancy or use after the emergency phase of an accident. Recovery includes both short-term and long-term activities. Short-term recovery returns vital systems to minimum operating standards, and short-term operations seek to restore critical services to the community and provide for the basic needs of the public. Long-term recovery focuses on restoring the community to its normal (or improved) state. The recovery period is also an opportune time to institute mitigation measures related to the recent emergency.

Reentry — Reentry refers to the temporary, short-term readmission of people to a restricted zone for the purpose of performing some essential task (e.g., emergency workers performing search and rescue operations or a farmer returning to an area to feed livestock) and those provisions leading up to the reoccupation or use of previously restricted zones after the hazard has been reduced to acceptable levels.

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* See Appendix A for a glossary of these and other technical terms used in this report.

Restoration — Restoration refers to removal of rubble and emergency repair of structures and facilities, culminating in reestablishment of major utilities and services. In the present context, removal and decontamination of all chemical agents also would be included. Social and economic activities return to near-normal levels.

The terms "recovery" and "restoration" have been used in combination to refer to the entire group of activities undertaken to prepare a previously contaminated and restricted zone (or area) for reoccupation or use.

The remainder of this report consists of five sections, a list of references, and three appendixes. Section 2 presents a brief overview of the origins of the chemical stockpile disposal and emergency preparedness programs and discusses the role of recovery in emergency planning in general. Relevant planning and experience with other chemical hazards, notably pesticides, are also described. Section 3 explains the transition from the initial emergency phase of an accident to the later phases, including a summary of how chemicals behave in the environment as time passes and the implications of this behavior for emergency planning. Section 4 is an exposition of major legal issues created by the need to restore the environment following a CAI. The section consists of a discussion of various federal and state statutes that regulate this process, as well as a short summary of existing provisions by the Army for compensating damage claims. Section 5, the longest section of this document, presents a set of restoration planning strategies that should be included in a plan, including sampling and monitoring, personnel protection, access control and reentry, ingestion pathway restrictions, decontamination, relocation needs and resources, medical and psychological considerations, public awareness, information processing, and economics. Section 6 presents the conclusions of this report. Finally, Section 7 contains the references cited, and three appendixes contain a brief glossary of technical terms (Appendix A), a list of state environmental authority and agency contacts (Appendix B), and a list of emergency and environmental hotlines (Appendix C).

2 BACKGROUND

2.1 OVERVIEW OF DISPOSAL OF THE U.S. CHEMICAL WEAPONS STOCKPILE

The U.S. Department of Defense (DOD) was directed by Congress in December 1985 to destroy the U.S. stockpile of lethal unitary chemical weapons in such a manner as to provide maximum protection to the environment, the general public, and the personnel involved in the destruction; to provide adequate and safe facilities designed solely for the destruction of the stockpile; and to provide cleanup, dismantlement, and disposal of the facilities upon completion of the disposal program (Public Law (P.L.) 99-145, DOD Authorization Act of 1986). The act was amended in 1988 to allow for disposal to be completed by April 30, 1997, and subsequently was amended again to allow for disposal to be completed in 1999. The Chemical Stockpile Disposal Program (CSDP) was established in 1986 by the U.S. Army Toxic and Hazardous Materials Agency (now the U.S. Army Environmental Center [USAEC]) to accomplish this mission.[1,2]

In the Army's *Final Programmatic Environmental Impact Statement for the Chemical Stockpile Disposal Program* (FPEIS),[3] the impacts of both normal operations (i.e., with no unintended release of chemical agents) and accident scenarios were considered for the disposal methods under examination. Disposal by incineration at the storage locations was identified as the preferred alternative from a health and environmental perspective. Following the January 1988 issuance of the FPEIS and the associated public hearings, Under Secretary of the Army James R. Ambrose decided on February 23, 1988, to proceed with on-site disposal of the stockpile of chemical agents and munitions, pending completion of site-specific analyses.[1,2] Those analyses are currently being conducted.

Stockpile disposal of unitary chemical weapons within the continental United States is to occur at the eight locations where these weapons are stored: Aberdeen Proving Ground (near Edgewood, Maryland); Lexington-Blue Grass Army Depot (southeast of Richmond, Kentucky); Anniston Army Depot (near Anniston, Alabama); Newport Army Ammunition Plant (near Newport, Indiana); Pine Bluff Arsenal (near Pine Bluff, Arkansas); Pueblo Depot Activity (near Pueblo, Colorado); Tooele Army Depot (south of Tooele, Utah); and Umatilla Depot Activity (near Hermiston, Oregon).

The inventory of material to be disposed of includes the organophosphate agents GA, GB, and VX, as well as the vesicant (blister) agents H, HD, HT (various formulations of sulfur mustard) and lewisite (or L, an organic arsenical) (see Table 1). These agents are stored in various munitions also — bombs, cartridges, mines, projectiles, rockets, and spray tanks — and also in ton containers. Toxicological properties and risks are discussed and summarized in several documents.[1,3-15] The current method of choice for agent destruction is high-temperature incineration.

TABLE 1 Types of Chemical Agents to Be Disposed of at Chemical Weapon Stockpiles

Agent	Description
GA	Tabun, $C_5H_{11}N_2O_2P$, an organophosphate nerve agent
GB	Sarin, $C_4H_{10}FO_2P$, a nonpersistent nerve agent
VX	$C_{11}H_{26}NO_2PS$, a persistent nerve agent
H	Sulfur mustard ($C_4H_8Cl_2S$) a blister agent
HD	Distilled sulfur mustard, $C_4H_8Cl_2S$, a blister agent
HT	Sulfur mustard-T, $C_8H_{16}Cl_2OS_2$ mixture, a blister agent
L	Lewisite, $C_2H_2AsCl_3$, a blister agent

2.2 CHEMICAL STOCKPILE EMERGENCY PREPAREDNESS PROGRAM

Should an unintended release of chemical agents occur during either storage or disposal operations, emergency preparedness and response, both on-post and off-post, would be vital. As part of a strategy to mitigate the potential environmental impacts of the current storage and planned destruction of chemical agents, the Army has undertaken the upgrading of on-post and off-post emergency preparedness at the eight storage/disposal locations in the continental United States. These upgrades will be implemented as part of the CSEPP.

To implement the various components of CSEPP, the Department of the Army (DA) and the Federal Emergency Management Agency (FEMA) entered into a memorandum of understanding establishing the roles and responsibilities of both agencies. The lead DA office for CSEPP is the Chemical Demilitarization Agency, Office of the Assistant Secretary of the Army for Installations, Logistics and Environment, at the Pentagon. The lead office for FEMA is the Chemical Stockpile Preparedness Branch of the Technological Hazards Division, Office of Technological Hazards, State and Local Programs and Support Directorate, at FEMA headquarters in Washington, D.C.

Several documents provide foundation information for chemical accident emergency preparedness and for this report. First, the document titled *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*[16] provides guidance and direction to local and state government officials in the development and maintenance of emergency plans for accidents or incidents involving stored lethal military chemical agents or disposal of these agents. Planning standards intended to present definitive requirements for preevent planning are being prepared as appendixes to the planning guidance document. The planning guidance and associated planning standards will apply to on-post as well as off-post preparedness. Second, a consolidated summary of general procedural guidance, technical information, and responsibilities to assist DOD forces in preparing for response operations to chemical surety accidents or incidents is given in the Department of the Army's *Chemical Accident or Incident Response and Assistance (CAIRA) Operations* publication (DA Pamphlet 50-6).[17] Chapter 14 of DA Pamphlet 50-6 deals with remedial operations and provides information of particular relevance to procedural aspects of recovery, reentry, and restoration. Third, individual installations have their own specific disaster control plans that incorporate CAI response and assistance plans — for example, the Pine Bluff Arsenal Disaster Control Plan Annex C.[18]

Finally, the report *Reentry Planning: The Technical Basis for Off-Site Recovery Following Warfare Agent Contamination*[4] contains extensive and relevant technical information. That report includes information on action levels for disposition of water and agricultural resources; protection and decontamination of agricultural resources; reentry intervals; dealing with contaminated human remains and personal effects; disposition of personal property and buildings; detection capabilities available for monitoring tissue/food and porous media; and recommendations for community emergency planning.

2.3 IMPORTANCE OF RECOVERY PLANNING TO EMERGENCY RESPONSE

Although relatively little study has been conducted of recovery processes on a community level, the research done to date clearly indicates that advance planning greatly improves recovery time. In *Recovery following Disaster*, Haas et al. note that "an exceptional performance in any one of the major recovery periods can reduce the time needed for that activity by as much as half."[19] Reduction of recovery time can, of course, result in a substantial reduction in cost. Some examples of the benefits of recovery planning include:

- Faster community recovery,
- Reduction of stress and conflict,
- More efficient use of resources,
- More efficient use of personnel,
- Increased ability to respond to social needs,
- Better coordination of services,
- Better record keeping,
- Improved ability to obtain grants and assistance,
- Increased acceptance of decisions,

- Reduction of unreimbursed expenses, and
- Better design of new facilities.

A rapid recovery should also contribute to more positive relationships between citizens and public officials.

Recovery planning is urgently needed. Current storage and eventual demilitarization operations could at any time be subjected to the effects of a tornado or earthquakes, an accident during demilitarization operations, or an accident during transport of munitions from storage to a demilitarization facility.[3,20] In addition to the advantages recovery planning would provide for the CSEPP, the construction of chemical weapons destruction facilities pursuant to the CSDP increases the need for such plans. The CSDP Final Programmatic Environmental Impact Statement states "The impacts from upset conditions (i.e., unintended releases resulting from accidents) specific to the on-site disposal alternative are dominated by earthquakes which can cause extensive plant damage at each site" (p. 2-95 of Reference 3). Thus, although the chance of an accident during the disposal program is small, such an event could be a multiple disaster that damages more than the disposal facility itself.

This possibility suggests that recovery planning could play an even more constructive role in the response. For example, identification of sources of temporary housing might become more important following an earthquake-induced chemical agent release than after an accident caused by improper munitions handling. Emergency planning for the chemical weapons stockpile will benefit from comprehensive recovery planning.

2.4 RELEVANT PLANNING AND EXPERIENCE WITH OTHER CHEMICAL HAZARDS

While chemical warfare agents present a unique hazard in accidents, much can be learned from experience and planning with other chemical hazards. In particular, because of the similarities of nerve agents to organophosphorus pesticides, experience with these pesticides may be helpful. Progress in dealing with reentry, restoration, and remediation in these related contexts can provide useful information for coping with the corresponding problems for chemical warfare agents.

2.4.1 General Planning for Accidents Involving Hazardous Chemicals

A primary purpose of emergency plans is to permit the initiation of timely, well-organized responses. Development of emergency plans for a given area generally requires the involvement of many agencies and personnel in the creation of a coordinated network of facilities that should function rapidly and precisely in the event of an emergency. In the early 1970s, intensive efforts were started to develop systems to meet chemical environmental emergencies.[21] Contingency planning in the United States is based on the National

Contingency Plan (Title 40, Code of Federal Regulations, Part 300 et seq. [40 CFR 300 et seq.]). This plan is discussed in further detail in Section 4.

Several data and action systems have been developed that have proved useful in cases of hazardous industrial chemical accidents. The Oil and Hazardous Materials Technical Assistance Data System (OHM-TADS) is a computer-based information depository developed by the U.S. Environmental Protection Agency (EPA). The Chemical Transportation Emergency Center (CHEMTREC) provides 24-hour telephone service to on-scene personnel supervising emergencies.[21] The Hazardous Materials Information Exchange (HMIX), sponsored by the Federal Emergency Management Agency and the U.S. Department of Transportation, is a computerized bulletin board designed especially for the distribution and exchange of hazardous materials information. It provides information pertaining to hazardous materials emergency management, training, resources, technical assistance, and regulations. Various hot lines and information telephone numbers are listed in Appendix C.

2.4.2 Specific Experience with Organophosphorus Pesticides

For at least 40 years, human toxic episodes have been reported to have been caused by dermal and/or respiratory exposure to toxic residues of agricultural pesticides. Although elemental sulfur may have been the first pesticide to cause a reentry problem through its tendency to cause ocular and dermal irritation, the OP insecticides have been the pesticides most responsible for the "reentry problem" and its recognition.[22] The insecticidal properties of certain OP compounds were discovered with the German World War II research on chemical warfare agents.[23] A few of those insecticides (e.g., parathion and methyl parathion) are still used in the United States, but a number of novel OP pesticides were developed later. Most of these compounds were developed to have appropriate chemical and toxic properties for specific uses in agriculture and public health.[23,24]

2.4.2.1 Comparison of Pesticide and Nerve Agent Toxicity

Control of pest population by pesticides usually means death of the organisms through inhibition of an enzyme or enzymes that are necessary for the maintenance of life. These enzyme systems may also be essential for human health and even life. That is, the same mode of toxicity may apply to both pests and people. This condition is the case with OP pesticides. The OPs — both pesticides and chemical warfare agents — inhibit certain ester hydrolyzing enzymes. The most important of these is the acetylcholinesterase enzyme, which is essential for maintenance of certain types of neural function.

Differences between OP agents and insecticides in the OP-enzyme reaction are largely a matter of the rates of various reactions and rates of absorption into the organism. Both types of OPs react with acetylcholinesterase through a series of steps to form the phosphorylated enzyme. This reaction tends to be faster with OP agents than with OP insecticides. Also, OP insecticides are largely dimethyl and diethyl phosphorothioates and do not contain secondary-alkyl ester groups. The presence of such a group, as with Soman

(GD, a nerve gas agent), increases the rate of reaction of the phosphorylated enzyme to form an irreversible bond that cannot spontaneously reactivate. The combination of these effects tends to make OP agents more toxic than OP insecticides.

2.4.2.2 Comparison of Pesticide and Nerve Agent Chemistry

A significant structural difference exists between most OP insecticides and OP agents in that the pesticides generally are phosphorothionates rather than phosphonates (as with GB and VX agents) or a phosphoramidate (GA agent). These structural differences tend to make the OP insecticides less reactive than the OP agents, and, therefore, the insecticides tend to be more stable in the environment. Physical properties such as volatility also affect the environmental behavior of these compounds.

In addition to these differences in persistence, the accidental release of chemical agent would lead to more variable residue levels in the environment than results from typical pesticide applications. Pesticides are intentionally introduced into the environment to control populations of pest organisms. Considerable effort during application is devoted to ensuring that the pesticide is distributed as uniformly as possible across the treated area and within the plant canopy. This uniformity of deposition would clearly not be true in case of an accidental release of a chemical warfare agent — OP or not. Such an event would, by its nature, be nonuniform. The amount of agent released would not be entirely predictable; the area of deposition would not be predictable since it would depend on wind speed and direction and their uniformity; and the amount of toxic agent residues deposited would also depend on other environmental variables, such as temperature, humidity, and precipitation during the movement of the agent through air. Thus, levels of toxic residues would be highly variable after an accidental release of chemical warfare agent.

2.4.2.3 Pesticide Regulation

Organophosphorus insecticides were introduced to U.S. agriculture about 1950, but their use was limited by the popularity and lower price of chlorinated hydrocarbon insecticides such as dichlorodiphenyltrichloroethane (DDT). The relatively low usage of the OPs meant that relatively low numbers of workers experienced the toxic effects of OPs. Also, workers usually recovered within a day or two, even after experiencing relatively severe OP toxic effects. Recognition of the OP reentry problem was delayed by these phenomena, coupled with a lack of experience with the toxic effects of the OP insecticides and the similarity of the toxic effects with symptoms of food poisoning, colds, etc. However, as use of chlorinated hydrocarbon insecticides declined, the use of the OP insecticides increased; the number of poisoning episodes increased; and the toxic hazard from OP residues was recognized. Recognition of this toxic hazard brought regulation.

Regulatory actions have been taken by both federal and certain state agencies to prevent toxic effects to agricultural workers. The U.S. Department of Agriculture and, since 1970, the EPA have taken actions to mitigate this problem as mandated under the Federal

Insecticide, Fungicide, and Rodenticide Act. These measures have usually been the establishment of reentry intervals and reentry levels. The reentry interval is the time that it would take for toxic residues to dissipate to the reentry level under specified environmental conditions. The reentry level is the amount of residues per unit area that would not cause any detectable toxic effect. The reentry level is not dependent upon the environmental conditions or the application rate. It is based solely on toxicity and the rate of residue transfer, primarily via dermal or inhalation exposure, to the affected population.

Other regulatory measures that have been taken include the refusal to permit use of a specific pesticide, as well as requirements that workers wear protective equipment. However, reentry intervals have been the primary regulatory measure for field worker protection. Reentry intervals for several pesticides were placed on labels before the establishment of the EPA in 1970, and in 1974 the EPA published Part 170 of Title 40 of the Code of Federal Regulations (40 CFR 170). Further details of early reentry regulatory history are provided in References 25 and 26. Both protective clothing and reentry interval requirements are included in 40 CFR 170. Of the 12 reentry intervals established in 40 CFR 170, 11 were for OP insecticides (40 CFR 170 is currently being revised). In separate actions, the EPA is requiring in a continuing program that reentry intervals and reentry levels be placed on labels of other pesticides.

Several models are used to set reentry intervals. The California Department of Food and Agriculture uses a model that is a combination of field experience and a rat dermal exposure system to estimate reentry levels for cholinesterase-inhibiting pesticides. The reentry interval is then calculated from field dissipation data as the time that must elapse for the pesticide residues to dissipate to the reentry level.

In 1980, the EPA proposed a more general model for the estimation of reentry intervals. In 1984 that model was published in Subdivision K of the Guidelines for Pesticide Registration[27] as support for 40 CFR 158.390. The model is called the "allowable exposure level" (AEL) method. It makes possible the setting of reentry levels and reentry intervals for any class of pesticide, regardless of the mode of toxicity. That is, it is designed to address reentry safety for OPs and all other pesticides. This model appears to afford a more appropriate methodology for ensuring safe reentry after accidental release of a chemical warfare agent. In addition, it permits the establishment of reentry levels for toxic materials without any hazardous human exposure tests.

The AEL method is based on the fact that a toxic effect occurs when the combination of human exposure and intrinsic toxicity reaches a critical level. The toxicity datum used here is the "no observed adverse effect level" (NOAEL). Since the NOAEL is determined by means of a finite number of animals (e.g., rats, mice, and rabbits), EPA uses appropriate safety factors. These safety factors are used to compensate for interspecies (i.e., animal to human) differences and for reliability of the data, which is related to the number of animals tested and responding and the strength of the response.

Various data submitted to the EPA as support for registration of pesticides have shown that out-of-doors exposure to pesticide residues in fields, groves, and vineyards is primarily dermal, with less than 1% from respiratory exposure. Therefore, a dermal NOAEL is the most appropriate toxicity for calculating a reentry level for out-of-doors pesticide uses. Dermal exposure should also be considered with exposure to residues of a chemical agent. Consideration of dermal exposure would be most important with the persistent agents — VX and the sulfur mustard agents. Where exposure to residues of any agent might occur, combinations of both dermal and inhalation exposure routes must be considered.

Appropriate reentry levels can be calculated with a combination of dermal toxicity and a transfer coefficient. Popendorf[28] demonstrated that foliar dislodgeable residues (FDRs) (as defined by methodology developed by Gunther et al.[29] and Iwata et al.[30]) are useful for predicting human dermal exposure. He showed that there is a linear relationship between FDRs and human exposure for the harvesting of tree fruit. Harvesting of tree fruit is interpreted to be a worst-case exposure scenario. The slope of Popendorf's correlation is called a transfer coefficient. Other studies have confirmed the applicability of transfer coefficients.

The EPA experience with reentry data indicates that it would be best not to rely on a reentry interval for safety after an accidental release of any of the chemical warfare agents. Reasons for this conclusion are that establishment of a reentry interval assumes that (1) the application rate for any given contaminated area is known, and (2) the rate of dissipation of the residues is known for that location (or alternatively that a worst-case rate is used for the calculation). Residue dissipation is a result of a combination of chemical reactions (e.g., hydrolysis, photolysis, and oxidation) and of physical processes (e.g., volatilization and runoff). All of these processes are affected by the environmental conditions at the location of release, which vary from location to location and from time of year to time of year, and even from day to day. The truly limiting factor here, though, is the fact that initial amounts of residue are not known and will vary widely. Without a starting residue level, estimation of reentry level is impossible.

A safer alternative would be to establish reentry levels for each chemical warfare agent and not to allow reentry until tests show that the existing residue levels are less than the established reentry level. Reentry levels are independent of the rate of dissipation and, therefore, are general for all of the possible sites. Disadvantages of this procedure are that suitable field test methods would have to be developed and used, and field test personnel would have to be trained and available. To minimize unnecessary or premature field testing, a sentinel animal could be used (e.g., ubiquitous birds such as sparrows). The presence of healthy animals of a sentinel species could be used as an indicator for field tests to be run where previously other animals had not survived. Alternatively, intervals might be established for delay before the start of testing. These intervals would be based on known rates of reaction and known rates of volatilization under the environmental conditions existing at the location. It should be stressed that such an interval would not be useful for the reentry of unprotected humans into contaminated locations.

3 MAKING THE TRANSITION FROM THE INITIAL EMERGENCY RESPONSE TO LATER STAGES OF CHEMICAL AGENT ACCIDENTS

3.1 TRANSITION FROM EARLIER TO LATER STAGES OF AN ACCIDENT

In the earlier stages of a chemical agent accident, the dominant risk to the public is from airborne release and inhalation of chemical agent. Before the early, or response, phase of the accident is considered over, the release will have been terminated and any munitions involved in the accident recovered and secured. Any airborne chemical agent will have dispersed during the response phase of the accident; civilians at risk in the affected areas will have been assisted with emergency protective actions; and the affected areas will have been secured. The concept and functions of the response phase and recovery phase have been set forth in DA Pamphlet 50-6.[17]

3.2 BEHAVIOR OF CHEMICAL AGENTS DURING THE LATER PHASES OF ACCIDENTS

Following its release, a chemical agent will be dispersed, diluted, and degraded as it migrates and undergoes physical and chemical changes in the environment. This process, in turn, will affect the abiotic and biotic components of neighboring and, perhaps, distant ecosystems.[31] A considerable literature exists on the environmental behavior of hazardous chemicals, including agent-related chemicals such as pesticides.[32,33] The toxicology and potential impacts of chemical agents on ecological resources are discussed in the CSDP Final Programmatic Environmental Impact Statement.[3]

The chemical agents under consideration include both persistent materials (e.g., VX and sulfur mustard agent) and nonpersistent materials (e.g., GB), although there is intermediate behavior.[4] While the nonpersistent agents will clear the area and disperse rapidly, persistent agents will remain for hours to days or longer, depending on weather conditions and terrain features, unless removed by decontamination. Natural degradation and detoxification of chemical agents occur in air, water, soil, and other media.[34] Natural processes may in some cases be very effective for the degradation of persistent agents. However, predicting the degree of reliance that it would be prudent to place on such processes appears to be very complicated in the light of current knowledge.[34] Consequently, it would appear that for the present, implementing comprehensive monitoring and analytical controls remains an essential requirement for ensuring that a formerly contaminated area is safe for unprotected personnel.

After the initial phases of the accident, the release of chemical agents will have been terminated, and escaped nonpersistent agents will have for the most part dispersed. However, some persistent agents may remain in liquid form (or as concentrated vapor evaporating or outgassing from residual liquid agent contamination) in scattered locations for longer periods. The extent of this contamination will depend upon the type of agent; how the agent has been dispersed; the quantities dispersed; and meteorological, topographic, and other conditions. The agent may penetrate some materials, particularly those with porous surfaces, and thereby persist for a considerable period. Moreover, remaining agent may be transported in certain environmental media.

While concentrations of the agent remain, several potential pathways exist for human exposure. If any localized concentrations of persistent agent remain in liquid form, direct dermal exposure can continue as a longer-term exposure pathway during the later phases of an accident. If remaining concentrations of persistent chemical agents vaporize, if localized concentrations of vapor remain, or if offgassing of agent occurs with rising temperature, inhalation can again provide an exposure pathway. If water supplies become contaminated, drinking water can be an exposure pathway. Internal exposure also will occur in humans if directly or indirectly contaminated foods are ingested. Characteristics and implications of the presence of persistent agents at significant concentrations are discussed in more detail in References 4, 35, and 36.

3.3 IMPLICATIONS FOR DECISION MAKING IN REENTRY PLANNING

For decision makers, the pressures of time and the necessary rapidity of response in the early stage of an accident are largely replaced by the pressures associated with complexity in the later stages of the accident.[37] When the early emergency response stage of the accident is over, decision makers will face the recovery stage. The recovery stage is potentially a much longer period during which the full impact of the accident will probably have to be assessed by a detailed monitoring and sampling program, and longer-term protective measures will have to be put in place. Provisions will have to be made for the needs of the evacuated population, both on a temporary basis and possibly including longer-term relocation. Restrictions on access to the affected areas may have to be established and subsequently modified as indicated by results of monitoring studies. Controls may have to be exerted on food and water potentially contaminated during the accident. Decontamination of, and reentry into, previously evacuated areas will have to be planned.

The later stages of a chemical agent accident also differ from the earlier phases in the options open to decision makers. During the earlier stages of an accident, some protective or remedial measures may be impossible or ineffective because of lack of time to implement them. However, in the later stages of the incident, the factors that place limits on what can be done may be expected to be mainly social, economic, and political, although technical limiting factors (e.g., detection capabilities for agents in various media) will remain.[37]

It is important to have preplanning in place for reentry and recovery and also to begin accident-specific reentry planning and recovery efforts during the initial response phase of the emergency. If reentry is seen or treated as something that is to begin only after completion of the response to the initial emergency, both time and critical information will be lost.[38-40] Should this situation occur, losses may be greatly and unnecessarily increased. Furthermore, it is very important for the group of people involved in making the decisions on recovery, reentry, and restoration and implementing these decisions to be coordinated with and integrated into the accident emergency response activities from the beginning.

4 LEGAL ASPECTS OF CHEMICAL STOCKPILE EMERGENCY PLANNING PROGRAM RECOVERY, REENTRY, AND RESTORATION

This section identifies the major environmental laws, regulations, executive orders, and permits that would apply to recovery, reentry, and restoration following a CAI and briefly describes the process of handling compensation claims. Various federal and state environmental statutes impose environmental protection and compliance requirements upon the DOD. Executive Orders 12088 (43 Federal Register [FR] 47707, October 1978) and 12856 (58 FR 4198, August 1993) require federal agencies to comply with applicable administrative and procedural pollution control standards established by federal environmental statutes. The major statutes of concern, treated separately in the subsections below, are the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA, 42 USC 9601-9675), as amended by the Superfund Amendments and Reauthorization Act of 1986 (SARA, P.L. No. 99-499, 1986); the Resource Conservation and Recovery Act (RCRA, 42 USC 6905-6974); and the National Environmental Policy Act (NEPA, 42 USC 4321 et seq.). Section 4.4 addresses state authority to regulate cleanup of a CAI. Section 4.5 briefly discusses the Army's claims compensation policies.

4.1 CERCLA RESPONSE PROCEDURES AND REQUIREMENTS

The Comprehensive Environmental Response, Compensation, and Liability Act specifies responsibilities and procedures to follow when a hazardous material spill occurs, including notification requirements and specifications for long-term cleanup and restoration activities.* The DOD is designated as the lead agency for response when the spill occurs "at or from" a DOD facility.† Thus, DOD would have primary authority and responsibility for

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* The CERCLA provides for federal response to releases or threatened releases of any "hazardous substance" [42 USC 9604(a)(1)(A)] or any "pollutant or contaminant which may present an imminent and substantial danger to the public health or welfare" [42 USC 9604(a)(1)(B)]. EPA regulations determine what materials are designated as "hazardous substances" under this statute. Those regulations leave the status of chemical agents unclear. Currently, it appears that at least M-55 rockets qualify as hazardous substances; other agents or agent-containing munitions may qualify depending on whether they are considered "waste" for RCRA purposes. However, any dangerous release or threatened release of agent not covered under the "hazardous substance" clause would be covered under the "imminent and substantial danger" clause. Therefore, CERCLA response authority would apply in any situation where a release or threatened release of agent poses a danger to public health and safety. Army policy and procedures as set forth in DA Pamphlet 50-6[17] are to initiate CERCLA and SARA notifications and response efforts immediately in the event of a CAI.

† Pursuant to Section 2(d) of Executive Order 12580 (January 23, 1987, 52 FR 2921), the functions vested in the President under CERCLA to initiate cleanups [Sections 104(a), (b) and (c)(4), 113(k), 117(a) and (c), 119, and 121 of CERCLA] are delegated to the Secretary of Defense with respect to releases or threatened releases where either the release is on, or the sole source of the release is from, any facility or vessel under the jurisdiction, custody, or control of the DOD.

meeting the requirements of CERCLA in the event of an agent release associated with chemical stockpile storage or disposal. Under SARA, federal facilities, including DOD's, are subject to the same cleanup requirements as privately owned facilities, but the federal facilities are not eligible for funding through the Superfund. The DOD's Defense Environmental Restoration Program (DERP) is generally responsible for funding and carrying out hazardous materials response operations at DOD facilities (see SARA Section 211, 10 USC 2701). However, it is not clear whether DERP funding would be available for cleanup at a CSDP facility if it is an active treatment facility licensed under RCRA (see AR 200-1, *Environmental Protection and Enhancement*, § 9-4.c). Figure 1 is a conceptual flowchart depicting the CERCLA response procedure.

4.1.1 Types of Response Action: Removal and Remedial Action

The CERCLA and EPA's implementing regulation, the National Contingency Plan (NCP, 40 CFR 300 et seq.), contemplate two types of actions in response to a chemical accident or incident: removal actions and remedial actions.

Removal actions are immediate, short-term response actions to address immediate health risks through temporary protective actions, cleanup, and removal of hazardous materials. Removal operations are coordinated by the on-scene coordinator. The scope of a removal action will vary depending on the specific circumstances involved; the regulations do not dictate any specific limitation on DOD-led removal operations (40 CFR 300.415). However, the regulations imply that EPA contemplates a limited scope for removal actions.*

Remedial actions are longer-term actions that include cleanup, treatment, neutralization of contamination, and, if necessary, access control or permanent relocation of residents.† Remedial actions are coordinated by the remedial project manager. No specific or implicit limitations exist on the scope of a remedial action. If possible, the remedial action is to restore the site to unlimited use with no adverse effects. Remedial actions can follow removal actions or can be initiated independently to address long-term hazards where there is no immediate hazard requiring short-term removal action. The National Contingency Plan contains extensive substantive and procedural requirements for remedial actions; they are discussed below in Sections 4.1.3 and 4.1.4.

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* At sites where cleanup is paid for by the Superfund, the National Contingency Plan limits the scope of removal actions to 12 months and $2 million. Although that limit does not apply to DOD-sponsored removal actions, it provides some indication of the intended meaning of the term "removal action."

† Responsibility for permanent relocation of residents would fall to FEMA pursuant to Executive Order 12580.

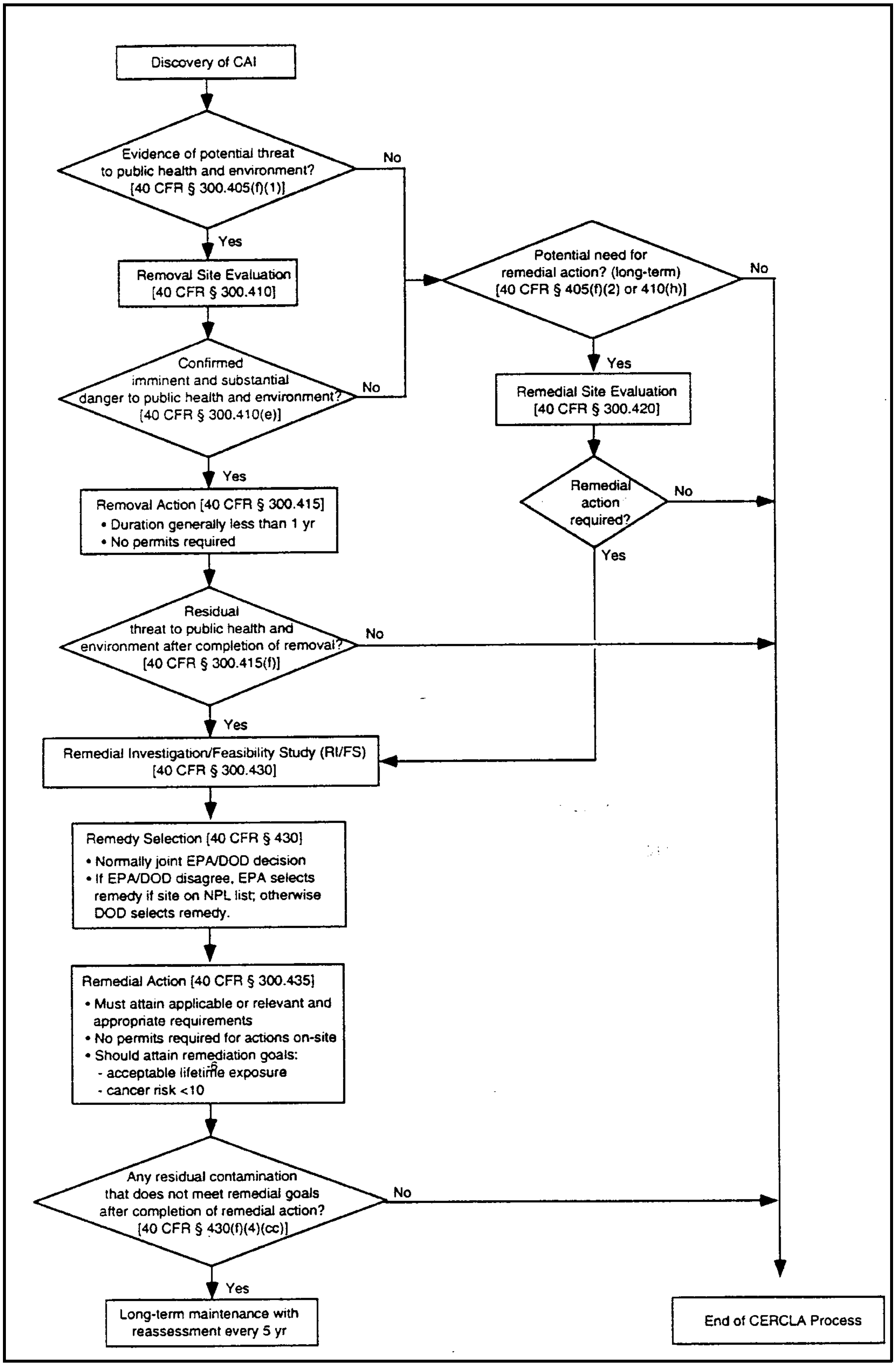

FIGURE 1 CERCLA Response Procedure for a Chemical Accident or Incident (CAI): Conceptual Flowchart

4.1.2 Army Organizational Responsibilities in Removal and Remedial Actions

The Army indicates in its CAIRA publication [DA Pamphlet 50-6, Section 3-6(a)][17] that removal operations are initiated as part of the "response phase," and remedial operations are initiated in the "recovery phase" of a CAI. During the response phase, the initial on-scene coordinator is the installation commander; if and when a service response force takes over response operations, the commander of that force becomes the on-scene coordinator [DA Pamphlet 50-6, Section 2-8(d)(3)]. During the recovery phase, "in most cases the long-term remedial operations from a chemical agent release will be included as part of the Defense Environmental Restoration Program (DERP) for the installation."[17] The installation commander is responsible for all Installation Restoration Program (IRP) operations at the installation, with technical assistance from the U.S. Army Environmental Center (AEC) and the U.S. Army Corps of Engineers (COE). Generally, the remediation work is performed by civilian environmental contractors under the supervision of the AEC and/or the geographic military district of the COE. The remedial project manager will be designated either by the AEC or the installation commander, who is responsible for approving remedial action decisions, providing notification and interface with other agencies and jurisdictions, implementing technical review and public involvement programs, and maintaining the administrative record [DA Pamphlet 50-6, Sections 14-2, 14-3(d)]. Further information on Army organizational responsibilities is provided in the April 1991 draft of the Chemical Service Response Force Commander's Emergency Response Plan.

4.1.3 Transition from Removal Action to Remedial Action

The National Contingency Plan describes two pathways for initiating remedial action — it can be initiated as a follow-up to a short-term removal action [40 CFR 300.415(f)], or it can be initiated without a previous removal action where there is contamination posing a long-range hazard but no immediate danger (40 CFR 300.420). In view of the acute toxicity of the chemical agents involved in the CSDP, it seems likely that any CAI requiring long-term remediation would also have required short-term removal and neutralization actions. Therefore, the expected sequence for an accidental agent release is removal followed by remediation where necessary.

The National Contingency Plan requires that if the lead agency determines "the removal action will not fully address the threat posed by the release," then the lead agency is to "ensure an orderly transition from removal to remedial action" [40 CFR 300.415(f)]. The National Contingency Plan does not give specific criteria for determining whether a health threat has been "fully addressed" as the term is used in this section. One reasonable approach to this determination would be to use the general goals for remedial action established in the regulations. Those goals are discussed in more detail below, but in essence they specify that there be no health risk associated with unrestricted use of the location, even by especially sensitive populations. The need for long-term remedial action could be assessed against this health-risk standard following completion of removal and neutralization actions. If no residual health risk exists, remedial action would not be necessary. Guidance on evaluating health risks associated with agent releases can be found in publications by Oak

Ridge National Laboratory[4] and the U.S. Department of Health and Human Services.[39] The persistence of some agents (VX and mustard agents) and the carcinogenic character of the mustard agents would appear to make remediation more likely in the event of their release, as opposed to the nonpersistent nerve agents GA and GB.

4.1.4 Overview of Remedial Action Process

The National Contingency Plan mandates a detailed process for conducting remedial actions (40 CFR 300.420-300.435). The process is reviewed in detail in the National Contingency Plan and addressed in DA Pamphlet 50-6 (Section 14-3). The major steps are:

1. *Site Inspection (SI)* — The SI involves initial data gathering, including environmental sampling, to assess the severity of the release and determine whether further action is needed. The SI results in a recommendation that either (1) no further action is required, (2) additional removal action is required, or (3) remedial operations are required.

2. *Remedial Investigation and Feasibility Study (RI/FS)* — The remedial investigation (RI) is the major information-gathering step in the process and involves a comprehensive assessment of the site. The feasibility study (FS) is undertaken concurrently with the RI and considers alternative techniques for remediation. The National Contingency Plan includes detailed guidance on how the RI/FS is to be conducted, including what should be studied, how remediation alternatives should be evaluated, specification of public input to the process, and other details.

3. *Record of Decision (ROD)* — The record of decision presents and documents the decision taken as to how remediation will be conducted. It includes a remedial action plan outlining exactly what will be done.

4. *Remedial Action (RA)* — Remedial action is the step when the site is actually cleaned up.

4.1.5 Substantive Remediation Standards

In developing a remedial action plan, the Army would have to address the degree of cleanup required: what standards must be met before the site is determined to be "clean"? The National Contingency Plan addresses remediation standards in terms of specific regulatory requirements ("applicable or relevant and appropriate requirements," or ARARs) and in terms of general health-oriented goals for remediation. The standards are described briefly below in Sections 4.1.5.1 and 4.1.5.2. In addition, the National Contingency Plan provides a set of criteria for evaluating and selecting from the various remedial action options revealed by the RI/FS. Those criteria are briefly described in Section 4.1.5.3. Lastly, negotiation of installation-state agreements regarding remediation standards is discussed in Section 4.1.5.4.

4.1.5.1 Applicable or Relevant and Appropriate Requirements

The CERCLA provides that remedial actions are to meet all applicable or relevant and appropriate requirements. This broad rule is intended to convey that the site should be cleaned up to meet whatever environmental quality or health standards may apply under the circumstances. It encompasses both state and federal standards. "Applicable" requirements, according to EPA, are:

> Those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that specifically address a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site.

"Relevant and appropriate requirements" are:

> Those cleanup standards, standards of control, and other substantive environmental protection requirements, criteria, or limitations promulgated under Federal or State law that, while not "applicable" to a hazardous substance, pollutant, contaminant, remedial action, location, or other circumstance at a CERCLA site, address problems or situations sufficiently similar to those encountered at the CERCLA site that their use is well suited to the particular site (EPA OSWER Directive 9234.1-01).

A survey of federal regulations reveals few references to chemical agents. In EPA regulations, the only references to chemical agents are in the SARA III release-reporting requirements (all of the lethal agents are included there), and the RCRA list of hazardous constituents (includes mustard agents only) (40 CFR 261, Appendix VIII). The RCRA requirements would apply as an ARAR at a chemical accident if the activity at the site during the remedial action constituted "treatment, storage, or disposal" of a "hazardous waste" within the meaning of RCRA. For instance, RCRA-regulated disposal would occur at an accidental release site when wastes from different areas were consolidated into one area, waste was removed and treated outside and redeposited into the same or another area, or waste was picked up from one area and treated within another area of contamination and then redeposited in the initial area.*

A few other references to chemical agents occur in federal regulations. Those regulations include (1) international arms trade regulations issued by the State Department (22 CFR 121.7) and the Treasury Department, Bureau of Firearms, Alcohol, and Tobacco

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* Transportation of RCRA hazardous waste would have to be done by an approved carrier, pursuant to 40 CFR 264 and Department of Transportation regulations at 49 CFR 100-199.

(27 CFR 47.21); (2) workplace process safety management regulations issued by the Occupational Safety and Health Administration (OSHA) (29 CFR 1910.119); and (3) regulations on pensions and compensation issued by the Department of Veteran's Affairs (38 CFR 3.316); and regulations on treatment of uranium mill tailings issued by the U.S. Nuclear Regulatory Commission (USNRC). Only the OSHA regulations would likely be relevant to a CERCLA remediation effort. In other words, there are no established federal standards specifically addressing allowable levels of chemical agents in drinking water, in navigable waters, in foodstuffs, or in any other media.[*] However, the Centers for Disease Control have promulgated nonregulatory recommendations for protection against potential adverse effects of long-term exposure to low doses of agent.[41] Efforts are currently underway to develop guidelines and control limits for return to evacuated areas, air, drinking water, dairy products, crops, and livestock feed and water; and a White Paper, *Estimated General Population Control Limits for Unitary Agents in Drinking Water, Milk, Soil, and Unprocessed Food Items*, is under review.[42,43]

At the state level, most of the chemical stockpile host states have regulations addressing chemical agents. Indiana, Kentucky, Maryland, Oregon, and Utah regulate waste chemical agents or residues from demilitarization as hazardous waste.[†] Maryland also regulates chemical agents as toxic air pollutants.[‡] There may also be other state and/or local regulations affecting chemical agent operations. In addition, a state statute enacted after (and in response to) a chemical incident could conceivably become an applicable or relevant and appropriate requirement.[§] In the event of a chemical accident or incident, it would be necessary to perform a new search for ARARs for the state or states involved. Appendix B lists state agencies to contact for that purpose.

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[*] The Code of Federal Regulations was searched by computer for references to chemical agents by commercial name and Chemical Abstract Service (CAS) number, yielding only the references described in the text.

[†] See 329 Indiana Administrative Code Section 3-6-9 (includes mustard gas only); Kentucky Revised Statutes, Section 224.865; Code of Maryland Regulations Sections 26.13.02.03, 26.13.02.17-18 (but liquids and residues from treatment by approved methods are excluded, see Section 26.13.02.26); 340 Oregon Administrative Rules Section 340-101-033(6)(b) (nerve agents only); Utah Hazardous Waste Rules, Table 2-II (residues only).

[‡] Code of Maryland Regulations Section 26.11.02.11-13.

[§] There is nothing in CERCLA or the National Contingency Plan to suggest that such a postaccident requirement would not be a valid ARAR. The only restriction on ARARs is found in CERCLA Section 120(a)(4) [42 USC Section 9620(a)(4)], which says essentially that states may not impose stricter standards for federal facilities than for other facilities in general. It is an open question whether a state-enacted chemical surety material (chemical agent) cleanup standard would run afoul of this restriction. One can imagine, for example, a standard that calls for special restrictions on *anyone* who releases lethal chemical agents; as a practical matter the Army is the only organization that would be affected since the Army is the only entity that owns or handles such materials.

ARARs must also be considered in light of the impact of remedial actions themselves. As examples, removal of topsoil may stir up dust in violation of clean air requirements, and actions taken in wetlands or affecting the drainage of wetlands may be subject to requirements of the Wetlands Protection Act.

If the preferred remedial action plan does not meet one or more of the ARARs, then the Secretary of Defense must provide the state with an opportunity to concur or not concur at least 30 days before the selection of a remedial action [CERCLA Section 121(f)]. If the state does not concur and desires to conform the remedial action to more stringent state requirements, the state may sue in federal court. If the state establishes that the decision is not supported by substantial evidence, on the basis of the administrative record, the remedial action must be modified. Otherwise, the state has the option of paying the additional costs to conform the remedial action to the state requirements.

4.1.5.2 General Remediation Goals

The National Contingency Plan stipulates that in developing and screening remedial action alternatives, the lead agency must consider, in addition to ARARs, the following general factors:

1. For systemic toxicants, acceptable exposure levels shall represent concentration levels to which the human population, including sensitive subgroups, may be exposed without adverse effect during a lifetime or part of a lifetime, incorporating an adequate margin of safety.

2. For known or suspected carcinogens (applicable to sulfur mustard), acceptable exposure levels are generally concentration levels that represent an excess upper-bound lifetime cancer risk to an individual of between 10^{-4} and 10^{-6} given information on the relationship between dose and response. The 10^{-6} risk level shall be used as the point of departure for determining remediation goals for alternatives when ARARs are not available (40 CFR 300.430).*

These provisions establish general substantive standards for cases where, as with chemical agents, there appear to be few applicable regulations.

4.1.5.3 Criteria for Evaluation of Remedial Action Alternatives

The feasibility study conducted before initiation of remedial action is intended to assess and compare various alternative techniques or plans for remediation. The National

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* State policy may be a factor in establishing acceptable cancer risk limits. For example, the state of Maryland has adopted a lifetime cancer risk standard of 1×10^{-5} for toxic air pollutants [Maryland Code of Regulations, Title 26.11 Part 01A(8).

Contingency Plan provides that nine criteria be considered in evaluating and comparing the alternatives [40 CFR 300.430(e)(9)]. The first two criteria are described as "threshold" criteria; any plan selected must be acceptable according to these criteria:

1. Overall protection of public health and the environment and

2. Compliance with ARARs.

The next five criteria are designated as the "primary balancing" criteria and are the main considerations to be balanced when selecting a preferred alternative:

3. Long-term effectiveness;

4. Reduction of toxicity, mobility, or volume of hazardous substances via treatment;

5. Short-term effectiveness;

6. Implementability; and

7. Cost.

The last two criteria are referred to as "modifying" criteria and should be used to review and, if necessary, modify the selection on the basis of the first seven criteria:

8. State acceptance and

9. Community acceptance.

4.1.5.4 Installation-State Agreements

Substantive remediation goals and standards may be negotiated in advance and incorporated into an agreement between the installation and the state. Negotiation of such an agreement would provide an opportunity for the host state and the Army to discuss and develop mutually agreeable standards for cleanup before a CAI has occurred. While not a binding contract, such an agreement could establish baseline standards and policies and help avert conflict between the Army and the host state in the event of a chemical agent release. Such an agreement could also incorporate requirements arising from the state's role as a natural resources trustee (see further discussion in Section 4.1.7).

4.1.6 Procedural Requirements in Removal and Remedial Actions

The National Contingency Plan and CERCLA set numerous requirements regarding the procedures to be used in assessing, reporting, and cleaning up hazardous materials spills. Some apply to any response operation, and some are specific to either removal actions or remedial actions. In general, remedial actions are subject to much more complex procedural requirements. The requirements are briefly summarized in the following subsections. Procedures for meeting those requirements are found in Chapter 14 of DA Pamphlet 50-6[17] and in other Army regulations and guidance documents (see, for example, AR 200-1, Environmental Protection and Enhancement).

4.1.6.1 Permit Requirements

The CERCLA contains one provision that simplifies response actions from a procedural standpoint — it exempts federal facility response actions from permit requirements. No federal, state, or local permits are required for response actions taken on-site [CERCLA Section 121(e)(1)]. "On-site" for this purpose means on the site of the CAI (i.e., the area subject to response operations). (If a site is declared a CERCLA unit, no permits are required for on-site activities.) Actions involving removal of material to another location would not enjoy the same immunity and might require transport and other permits.

4.1.6.2 Required Interaction with EPA

In the event of a CAI, the Army may take emergency removal action in case of an imminent and substantial danger to human health or the environment. Once emergency action is completed, EPA (and the state) must be given an opportunity to review and comment on response plans (10 USC 2705). The National Contingency Plan describes EPA's formal role:

- Pursuant to SARA Section 211, the environmental restoration program in general is to be carried out "in consultation with the Administrator of the EPA" [SARA Section 211(a)(3)]. The installation commander is responsible for seeing that appropriate interactions occur.

- The EPA is to review and approve environmental sampling and analysis plans whenever environmental samples will be collected before removal actions are started.*

- The EPA is included in the technical review committee that is set up to review and coordinate the RI/FS.†

- The EPA's formal role in the decision process for approving remedial action depends on whether the CAI site is on the National Priorities List (NPL). The NPL, which is maintained by the EPA, lists sites with high

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* 40 CFR 415(b)(4)(ii); the EPA review requirement only applies when there is at least 6 months available before removal actions must be started.

† DA Pamphlet 50-6 [Section 14-5(c)(2)] provides for establishment of a technical review committee to review and comment on actions and proposed actions with respect to hazardous substance releases at DOD installations.

> priority for CERCLA cleanup efforts. One specific consequence of the site's inclusion on the NPL would be that the EPA Administrator would have the ultimate authority to choose the remediation method.*

Relative to the last point, four of the eight chemical weapons stockpile installations (posts) already have sites on the federal NPL;† however, it is not clear whether that situation in itself would suffice to give EPA the final authority to choose the remedy in event of a accidental chemical release at one of those installations. Whether the CAI cleanup became part of the ongoing NPL site remediation apparently would depend on the exact location of the CAI and the boundaries of the NPL site, as defined in the associated Federal Facility Agreement (FFA). Although this specific issue has not been resolved by regulation or litigation, it appears that the CAI site cleanup would be subsumed under the ongoing NPL site-remediation process only if the CAI site were within the existing NPL site as defined in the FFA governing remediation of the NPL site. In other words, if the FFA defined the NPL site as one area (subpart) of the post, and the CAI occurred in another area or off-post, then the CAI site would not necessarily be subsumed under the existing NPL remediation process. The final remediation decision then would be left to the Army, unless the CAI site was placed on the NPL separately. On the other hand, if the CAI occurred within the boundary of the existing NPL site, the associated FFA would have to be modified to include the remediation effort associated with the CAI.

A CAI site could be placed on the NPL by one of three mechanisms. The first, and currently most common, mechanism for placement on the list is that a site is proposed for inclusion by the state; then the site is evaluated by the EPA according to the Hazard Ranking System (HRS). The HRS consists of a set of criteria for determining the severity of the hazard posed by the site; a high score on the HRS evaluation indicates that the site is suitable for inclusion on the NPL. The evaluation of a CAI site under the HRS would depend on the particular situation, including the area affected, the presence of agent decomposition products or decontamination by-products, and other factors.

The second method for inclusion on the NPL is through a priority selection by the involved state. Under the National Contingency Plan, each state is allowed to designate one site (over the lifetime of the Superfund program) as its top priority site, thus bypassing the normal evaluation and ranking process. Presumably, such a decision would not be taken lightly by a state unless it perceived a severe residual hazard to the public. In addition, the particular state might have already designated another location as its top priority site.

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* 40 CFR Section 430(f)(4); remedy selection is normally a joint decision. EPA's authority over remedy selection would become relevant only in the event of an irreconcilable disagreement between EPA and DOD. NPL listing also carries other consequences. If the site is listed on the National Priorities List, additional requirements under Section 120(e) of CERCLA apply, setting forth schedules for completion of certain tasks, including the RI/FS, and execution of an interagency agreement with the EPA for the expeditious completion of all necessary remedial actions.

† Aberdeen Proving Ground, Anniston Army Depot, Tooele Army Depot, and Umatilla Depot Activity; see listing in 57 FR 47180, October 14, 1992.

The third mechanism for inclusion on the NPL is through direct certification by the EPA. The EPA may include a release on the NPL if:

1. The Agency for Toxic Substances and Disease Registry of the U.S. Department of Health and Human Services has issued a public health advisory that recommends dissociation of individuals from the release,

2. EPA determines that the release poses a significant threat to public health, and

3. EPA anticipates that it will be more cost effective to use its remedial authority than to use its removal authority to respond to the release.

The latter mechanism may not be available in the case of federal installations because it appears to assume, in condition 3, that EPA will be funding the response.

4.1.6.3 Notice and Comment Requirements

Notice and comment requirements apply both to removal and remedial actions. For all removal actions, the lead agency is to perform the following public notice and comment functions [40 CFR 300.415(m)(1), (2), and (4)]:

- Appoint a spokesperson to provide information about the response action;

- Compile an administrative record and publish a notice in a local newspaper that the administrative record is available for review;*

- Collect public comments for a period of at least 30 days;

- Prepare written responses to significant comments; and

- If a period of six months or more is available before removal operations begin (unlikely for a CAI), then the agency must prepare an "engineering evaluation/cost analysis" (EE/CA) of the proposed removal action, publish notice of its availability, collect comments on it, and prepare written responses to any significant comments.

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* The administrative record is to contain all items used in the decision-making process associated with the response action. According to DA Pamphlet 50-6, Section 14-5c(8)(a), the record should include such items as "reports, plans, correspondence, transcripts, regulatory and public comments and responses to the comments, and decision documents."

The following additional actions must be taken when the removal action will extend beyond 120 days (in that case, before the end of the 120 days) or if there will be an RI/FS (in that case, before beginning work on the RI/FS) [40 CFR 300.415(m)(3) and 300.430(c)(2)]:

- Conduct interviews with local officials, residents, public interest groups, and other interested parties;
- Prepare a formal community relations plan to ensure the public an opportunity to learn about the site and participate in site-related decisions; and
- Establish and publicize a local information repository that contains the required administrative record materials and is open to the public.

After the RI/FS process, when there is a proposed remedy, a separate set of notice and comment requirements come into force [40 CFR 430(f)(3)]:

- Include the proposed plan and supporting analysis in the available administrative record;
- Publicize its availability;
- Collect comments for at least 30 days and extend the comment period at least another 30 days upon request;
- Hold a public meeting near the site during the comment period to collect oral public comments;
- Record and keep a transcript of this meeting; and
- Prepare a written summary of significant comments and information submitted, together with written responses.

Chapter 14 of DA Pamphlet 50-6[17] summarizes remedial operations.

4.1.6.4 Documentation of Remedial Action Decision

After a remedial action has been chosen, the plan adopted is to be documented, along with its supporting rationale, in a record of decision [40 CFR 300.430(f)(5)]. The National Contingency Plan specifies that the record of decision must cover the nine evaluation criteria for remedial actions (Section 4.1.5.3) and address whether and how the selected remedy will achieve the remediation goals.

4.1.6.5 Occupational Health and Safety Requirements

Response operations of a military nature (carried out by uniformed military personnel using military equipment and systems) are not subject to civilian occupational safety and health requirements. Response or remedial actions undertaken by other parties, however, generally must comply with OSHA standards for response-action worker safety and health (Standards for Hazardous Waste Operations and Emergency Response, 29 CFR 1910.120). The OSHA standards (or equivalent state or EPA standards) apply to federal agency, state, local, and private contractor employees. Each employer is responsible for protecting its own employees in conformance with these standards.*

4.1.7 Natural Resource Damage Claims

In addition to being required to comply with other sections of CERCLA, DOD is also accountable for so-called "natural resource damages" resulting from a CAI. The policy behind this part of the law is that those who are responsible for releases of hazardous substances must pay for any necessary restoration of damaged natural resources, even if that cost exceeds the use value of the lost resources.[44] This section explains the functions of natural resource trustees and the implications of this concept for CSEPP planning.

4.1.7.1 Definition of Natural Resources

Natural resources are defined broadly in Section 101 (16) of CERCLA as including the following:

> Land, fish, wildlife, biota, air, water, ground water, drinking water supplies, and other such resources belonging to, managed by, held in trust by, appertaining to, or otherwise controlled by the United States . . . [or] any State . . . [or] local government.

In other words, any component of a natural ecosystem (exclusive of man-made structures) that is overseen by a unit of government could be viewed as being a natural resource for the purpose of this law.

The extent of control that the United States, a state, or a local government must exercise over a property for it to fall within the definition of a natural resource is currently uncertain. While the court in *Ohio v. Department of the Interior* (Reference 44 at 459-461) held that "purely private resources" are not "natural resources" under Section 101(16), it concluded that the U.S. Department of the Interior's (DOI's) regulatory definition

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* See Occupational Safety and Health Act, 29 USCS Sections 652, 668; SARA Section 126; 40 CFR 300.150, and explanatory material in Federal Register, 55 FR 8679-8680 (March 8, 1990); Occupational Safety and Health Administration Standards for Hazardous Waste Operations and Emergency Response, 29 CFR 1910.120, and Executive Order 12196 of February 26, 1980, Occupational Safety and Health Programs for Federal Employees, especially Section 1-101.

[44 CFR 11.14(z)] of where the purely private resource ends and those covered by Section 101(16) begin was unclear. DOI proposed a rule addressing this question on April 29, 1991 (56 FR 19,752), but has yet to finalize it (see DOI regulatory agenda, October 25, 1993 [58 FR 56,456]). The answer must await completion of this process. Nevertheless, it is reasonable to expect that a shared natural commodity such as groundwater could be a state natural resource, depending on how state law regulates its ownership and use.

4.1.7.2 Responsibilities of Natural Resource Trustees

The responsibility to recover for damages to natural resources is given by Section 107(f) of CERCLA, independently of the rest of this act, to "natural resource trustees." Natural resource trustees may be the federal government, state governments, or Indian tribes (40 CFR 300.600-610). In the case of the federal government, the National Contingency Plan generally designates the head of the agency that manages land or resources as its natural resource trustee (40 CFR 300.600). Thus, not only is the Secretary of Defense probably the trustee for natural resources located on Army depots, but the Secretary of the Interior likely is the trustee for many non-DOD federal lands. The President has provided for selection of a "lead administrative trustee" from among federal agencies that have natural resource trustee responsibility in the event of a spill (Executive Order 12,777, §I, October 18, 1991).

The position of state governments is analogous, except that state trust responsibilities implicitly cover local government natural resources within that state. As the National Contingency Plan specifies (40 CFR 300.605):

> State trustees shall act on behalf of the public as trustees for natural resources within the boundary of a state or belonging to, managed by, controlled by, or appertaining to such state.

When more than one entity may bear trusteeship responsibilities for the same natural resource, the National Contingency Plan urges those entities to "coordinate and cooperate in carrying out these responsibilities" [40 CFR 300.615(a)] but mandates no process for this coordination and cooperation to take place.

Natural resource trustees have substantial rights and responsibilities. Upon discovery of threatened or actual damage to a natural resource, the National Contingency Plan empowers such trustees to survey the situation; cooperate with the on-scene coordinator; carry out damage assessments in accordance with DOI regulations; or restore, rehabilitate, or replace the resource [40 CFR 300.615(c)]. In addition, federal trustees may request the Attorney General of the United States to seek compensation from parties responsible for the damages, and any trustee may request the lead agency for a cleanup to remove or remediate the release [40 CFR 300.614(d)-(e)].

The process of carrying out a natural resource damage assessment is somewhat in doubt at this writing. The court in the companion cases of *Ohio v. Department of the Interior* (Reference 44 at 432) and *Colorado v. Department of the Interior* (Reference 45 at 481) found the implementing regulations (43 CFR 11) deficient in certain respects and remanded them to the DOI for revision and clarification. The DOI has published a Notice of Proposed Rulemaking in response to these decisions (56 FR 19,752 [1991]). Final conclusions regarding the difficulty of and requirements for carrying out natural resource damage assessments will have to await completion of these regulations, but the possibility must be recognized that paying for natural resources restoration pursuant to an assessment under these regulations could be more costly than if the responsible person were to carry out a remedial action directly.

4.1.7.3 Liability to Trustees for Damages to Natural Resources

Section 107(a)(4)(C) of CERCLA creates an independent procedure from other CERCLA liability provisions (Reference 44 at 439) for a party to pay any natural resources damages for which it is responsible. Subject to certain limitations, this section states that:

> The owner and operator of . . . a facility . . . from which there is a release . . . which causes the incurrence of response costs, of a hazardous substance shall be liable for . . . damages for injury to, destruction of, or loss of natural resources, including the reasonable costs of assessing such injury, destruction, or loss resulting from such a release.

Because DOD presumably would be the owner and operator of the storage facilities from which a release of chemical agent could originate, DOD would likely be responsible for this liability. Under Section 107(f)(1) of CERCLA, this liability could be to a state or an Indian tribe. Under the same section, the extent of natural resources liability is specifically limited so that a responsible party need not pay for natural resources damages if it has already remedied the situation under another section of the act.

4.1.7.4 Implications of Natural Resource Damages for CSEPP

The existence of natural resources damages has important implications for reentry and restoration planning under the CSEPP. Although the remainder of CERCLA makes it clear that DOD is the lead agency for a remedial action following a CAI, with states and other federal agencies assigned a specific supporting role, Section 107(a)(4)(C) creates a potentially duplicative cleanup process. It is entirely possible that disagreements between DOD and a natural resource trustee regarding the necessary extent of a remedial action could result in an independent cleanup.

The CSEPP planning process could reduce the chances for such conflict. A cooperative baseline survey in each protective action zone (PAZ) could catalogue each natural resource and the identity of its trustees. An interagency memorandum of understanding specifying in advance the responsibilities for remedial action and compensation could be developed pursuant to applicable Army regulations (e.g., Army Regulation 200-1, Chapter 12-6), and other appropriate regulations, and executed by all of the trustees. This procedure would provide a decision-making process for remedial actions that is created under less pressure and could reduce the time to restore or replace these resources after accidental release of a chemical agent.

4.2 RCRA APPLICATION AND REQUIREMENTS

The Resource Conservation and Recovery Act regulates the treatment, storage, and disposal of hazardous waste. Two ways exist by which RCRA requirements could play a role in restoration and recovery following accidental release of a chemical agent. Figure 2 is a conceptual flowchart depicting the RCRA corrective action process. First, as described in Section 4.1.5.1, the cleanup operation could constitute a "hazardous waste disposal" under RCRA if the accidental release involved a material within the RCRA definition of hazardous waste (mustard agent, or in some states, other agents as well) and if the operation involved actions of the type that fall within the definition of disposal.[*] In other words, RCRA requirements could apply directly to recovery and restoration operations, in addition to being applied as an ARAR under CERCLA. At least one court case supports the proposition that RCRA requirements still apply when a CERCLA remedial action is being carried out.[46] The permit exemption under CERCLA [Section 121(e)(1)] might not apply with respect to RCRA hazardous waste disposal permits.

The second way that RCRA could play a role is through application of "corrective action" requirements associated with RCRA permitting. The treatment facilities for the Army's chemical agent stockpiles will all hold interim permits under RCRA, and thus will be subject to RCRA requirements under RCRA Sections 3004 or 3008 regarding cleanup of hazardous waste spills. These requirements are independent of, although in some respects similar to, CERCLA cleanup requirements. Depending on a complex combination of factors, corrective action requirements to clean up a spill might:

- Apply only to spills of RCRA-listed waste or to any hazardous waste,
- Apply only to spills originating from the permitted disposal or storage facility or to spills originating from anywhere within a broadly defined "facility,"
- Be under the jurisdiction of the state or the EPA, and
- Be enforced via a permit condition or by direct administrative order.

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* For example, "disposal" would be involved if wastes from different areas were consolidated into one area, waste was removed and treated outside and redeposited into the same or another area, or waste was picked up from one area and treated within another area of contamination and then redeposited in the initial area.

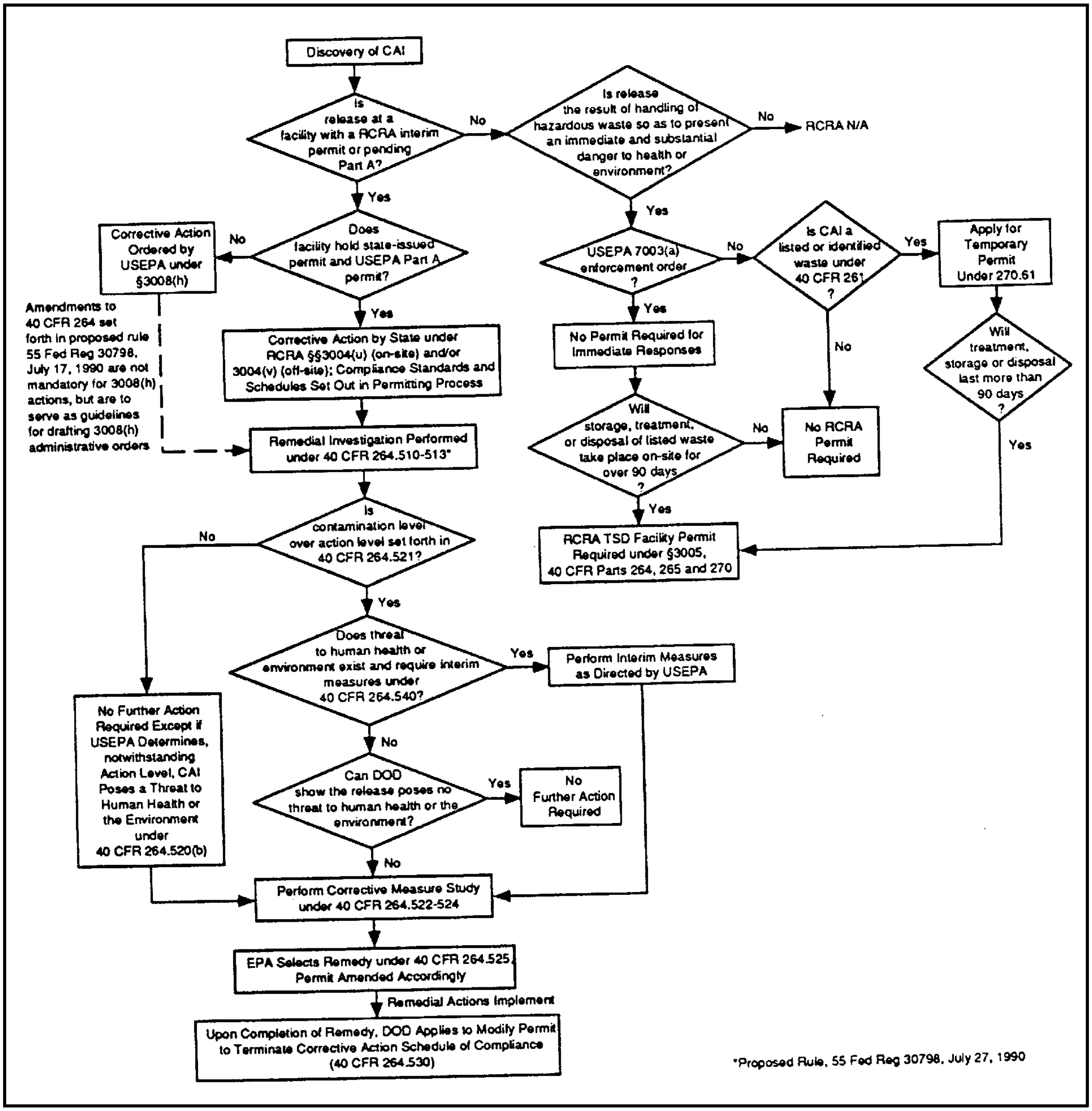

FIGURE 2 RCRA Corrective Action: Conceptual Flowchart

The EPA has issued proposed regulations specifying a procedure for implementing RCRA-required corrective actions under RCRA Section 3004 (55 FR 30,798 [July 27, 1990]). Under the proposed rules, if the release occurred at a facility with a RCRA interim permit or a pending Part A application, a corrective action could be ordered, and DOD would be obligated to perform a remedial investigation (40 CFR 264.510-264.513) to determine if the contamination level was over the action levels set in the regulations (40 CFR 264.521). If the levels were sufficiently high, DOD would have to perform interim measures as directed by the EPA or the state agency. If the release posed a threat to human health or the environment, EPA or the state could order DOD to perform a corrective measure study (40 CFR 264.522-264.524). The proposed rules are not mandatory for Section 3008(h) actions but are to serve as guidelines for drafting Section 3008(h) administrative orders.

4.3 NEPA APPLICATION AND REQUIREMENTS

Under provisions of the National Environmental Policy Act (NEPA, 42 USC 4321 et seq.), all agencies of the federal government shall include in every recommendation or report on proposals for major federal actions significantly affecting the quality of the human environment, a detailed statement by the responsible official relative to the environmental impact of the proposed action, any adverse environmental effects that cannot be avoided, alternatives to the proposed action, and any irreversible and irretrievable commitments of resources involved in the proposed action. Recovery and restoration of an accidental chemical release site might be such a "major federal action significantly affecting the quality of the human environment," depending on exactly what types of activities were involved and their environmental impact.

The Army's regulations for implementing NEPA (AR 200-2; 32 CFR 651) describe the process for determining the level of environmental analysis required (depending on whether a proposed action is a major federal action significantly affecting the quality of the human environment), producing the required environmental documentation, and fulfilling the associated notice and comment requirements. The regulations specify that the Assistant Secretary of the Army (Installations, Logistics, and Environment, or I,L&E) is the responsible official for NEPA compliance. Heads of Department of Army headquarters agencies are to initiate the preparation of necessary environmental documentation.

In an emergency situation following a CAI, such as containment and removal actions necessary to protect life or property, the Army may need to take immediate actions that have environmental impacts without first conducting an environmental assessment. As stated in the Army's regulations, "In no event will [the] Army delay an emergency action necessary for national defense, security, or preservation of human life or property to comply with this regulation or [NEPA regulations]" [32 CFR 651.9(b)]. When such an emergency action is taken, the regulations provide that the Headquarters, Department of the Army, proponent will notify the Army Environmental Office, which in turn will notify the Office of the Assistant Secretary of the Army (I,L&E), which will coordinate with the Assistant Secretary of Defense for Production and Logistics (ASD [P&L]) regarding the emergency action [32 CFR 651.9(b)].

Once the emergency phase of response is over and the recovery and restoration phase is initiated, NEPA requirements would seem to apply. However, the NEPA requirements for consideration of alternatives, public review of proposed actions, and documentation of program decisions are substantially parallel to those of the CERCLA remediation process. The EPA has been unable to reach a conclusion as to whether this parallelism means that NEPA does not apply to CERCLA cleanups, or that NEPA and CERCLA both apply but their documentation can be combined, or that separate NEPA documentation is necessary.[47] Army policy is to acknowledge the application of NEPA to installation restoration projects (32 CFR 651.8) but to combine NEPA and CERCLA documentation whenever possible. According to Army Regulation AR 200-2,

> In most cases, when a FS [feasibility study] is prepared in accordance with 40 CFR Part 300 [the National Contingency Plan], a second NEPA document is not required. As a matter of policy, the organization preparing the FS will ensure the document also complies with 40 CFR Parts 1500 through 1508 [NEPA compliance regulations, implemented by the Army at 32 CFR 214]. The cover of the FS and the subsequent ROD will contain the legend, "This document is intended to comply with the National Environmental Policy Act of 1969" [32 CFR 651.8(ii)].

4.4 CLAIMS FOR COMPENSATION AND RELIEF

A CAI with significant off-post consequences would likely generate numerous claims for compensation for damage. Allocation of legal liability to pay such claims would depend on the particular circumstances of the CAI and on a number of complex legal factors. Analysis of these factors is beyond the scope of this document. However, it should be noted that the Department of the Army has established a mechanism for evaluating Army liability and processing claims on a priority basis, where it determines that it is appropriate to do so. Chapter 10 and Appendix I of DA Pamphlet 50-6 describe responsibilities and procedures for setting up and operating a special claims processing office.

In addition, FEMA has established procedures for distributing disaster relief aid, pursuant to the Stafford Act.* The Stafford Act authorizes FEMA to assist state and local governments with disaster planning and authorizes federal assistance with relief efforts in disasters where state and local resources are overwhelmed. Assistance under the Stafford Act depends on a Presidential declaration of necessity. The act establishes two categories of Presidential declarations — "emergency" and "major disaster" — with corresponding levels of federal assistance. An "emergency" declaration can be requested by the governor or can be initiated by the President if the emergency situation is "one for which the primary

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* 42 USCS Sections 5121 et seq.; formerly known as the Disaster Relief Act, P.L. 100-707, this law was designated on November 23, 1988, as the "Robert T. Stafford Disaster Relief and Emergency Assistance Act." The Stafford Act establishes the familiar program for federal disaster relief that is implemented following hurricanes, earthquakes, and other major disasters.

responsibility rests with the federal government."[*] Federal assistance for emergencies is limited to short-term efforts to protect lives, health, and property, including providing for temporary housing assistance and debris removal. Expenditures are limited to $5 million unless the FEMA associate director determines that there is a continuing unmet need for assistance (44 CFR 206.66) and makes a special report to Congress (44 CFR 206.67).

According to FEMA, "no long term or permanent restorative assistance is authorized" under an emergency declaration (42 USC §5122(2)). Conversely, a "major disaster" declaration authorizes long-term assistance of various kinds, including long-term housing, disaster unemployment assistance, individual and family grant programs, grants to restore public facilities, community disaster loans, and others, with no overall financial limit. Unlike the case for a declaration of emergency, the President may not initiate a declaration of major disaster; the governor must request it. However, it should be noted that the Stafford Act defines "major disaster" so as to include only natural disasters and "any fire, flood or explosion" (42 USC 5122(2)). Therefore a CAI may not meet the Stafford Act's definition of a "major disaster" unless it is associated with a fire, flood, or explosion. A release stemming from a purely mechanical failure (e.g., a leaking container), apparently would not fit within the definition and therefore would not be eligible for long-term disaster assistance from FEMA.[†] However, assistance for long-term community needs would be available from the Army.

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[*] FEMA Disaster Assistance Regulation 44 CFR Part 206, Supplementary Information; 54 FR 22163 (May 22, 1989).

[†] A bill to amend the Stafford Act has been introduced in the 103rd Congress (S. 1697, November 19, 1993). The bill would, among other things, change the definition of "major disaster" so as to include a CAI, regardless of cause.

5 ELEMENTS OF RESTORATION PLAN STRATEGY

The first four sections of this report have discussed the purpose, rationale, and background of the Chemical Stockpile Emergency Preparedness Program (CSEPP), as well as the nature of chemical agents, general aspects of emergency management, and applicable regulations or public laws. This section describes in further detail various elements of recovery and restoration that should be considered by planners and responsible organizations involved in the CSEPP. These elements, in combination, are intended to provide information, stimulate discussion and problem-solving, and lay the groundwork for further development of individualized recovery and restoration plans.

5.1 MONITORING PLAN: ASSESSMENT OF CONTAMINATION REMAINING AFTER THE INITIAL STAGE OF THE ACCIDENT

5.1.1 General

Protective and recovery actions conducted in the later stages of an accident should have as a goal protection of the health of the public and emergency workers. Achieving this goal requires knowledge of the presence and levels of agent remaining in contaminated areas. A well-organized and effectively implemented monitoring program is thus an essential element in a restoration plan.

Contamination following a chemical agent release may be expected to be local; that is, a certain area contiguous to the installation will be affected. However, it is important for planners to recognize that for some accident scenarios, the size of the area that would require monitoring could be considerable. For some accidents of extremely low probability, the area could cover hundreds of square miles. The monitoring program might also extend over a prolonged period and might involve many people taking large numbers of samples and measurements. Because of the potentially large amount of information to be collected, processed, and analyzed, careful attention must be given to documentation procedures, data management, and information processing.[37,42,43,48,49]

Whatever the size of the monitoring program, the predictions of theoretical modeling of plume dispersion can assist in helping interpret the measurements, in predicting exposure pathways and exposure levels as a function of time, in evaluating the probable impact of various possible mitigative measures, and in providing a basis for determining where initial surveys after the CAI should be conducted.[50] However, it is important to be aware of the limitations of model projections and to be realistic about their application. Models now in use were designed primarily for inhalation exposure analysis rather than for environmental contamination prediction. The current models are somewhat limited (e.g., two-dimensional, unable to deal with topographic features and unable to deal with deposition very well).

Agent detection and monitoring is discussed in the report *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*,[16] in DA Pamphlet 50-6,[17] and in *Reentry Planning: The Technical Basis for Offsite Recovery Following Warfare Agent Contamination*.[4]

5.1.2 Environmental Monitoring

Extensive general information on environmental monitoring is provided in the technical literature.[51-53] Further information on environmental monitoring in event of a chemical agent emergency is given in DA Pamphlet 50-6.[17] It may be desirable to obtain baseline environmental data to characterize further the environment near each of the eight chemical weapons storage locations. Such data collection was recommended at a technical session of the Reentry Guidance Development Workshop held in Pine Bluff, Arkansas, in September 1990.[54] At each location, information would need to be collected on soil characteristics, land use, and building locations for the entire area where agent deposition could occur.[39] Soil in the area would be sampled to determine baseline concentrations of agents, characteristic metabolites of agents, and other chemicals that would interfere with measurement of any newly released agent.[39] Baseline survey sampling should be limited by a realistic appraisal of what can be accomplished and should be linked to the sampling plan for response to releases.

5.1.3 Planning the Monitoring and Sampling Operations

Optimally, planning for monitoring and sampling should be done in two stages: preliminary planning, which would be part of normal on- and off-post emergency preparedness for each installation; and the final detailed planning, which would be initiated at the onset of the accident and would take into account accident-specific information. Thus, optimally, a preliminary monitoring and sampling plan should be in place.

The monitoring organization and program should be of a size and structure appropriate for the magnitude of the accident that has occurred. Priorities and courses of action should be dictated by the size and characteristics of the affected areas, the nature of the accident, the resources available (such as personnel, equipment, and instrumentation), and estimates of the time-scale of the protective and recovery operations.[37,55] A decision as to which organization or organizations are responsible for monitoring and sampling should be reached early to permit, among other activities, training of personnel and acquisition of equipment in advance of any emergency.

5.1.4 Management of the Monitoring and Sampling Program

During the later stages of an accident, several organizations or agencies may be charged with conducting parts of the monitoring program and recovery operations or may offer advice or assistance. Therefore, it is important that an organization be established to coordinate the actions of the participating groups, assign tasks, gather information, process data, and advise the authorities in charge of various remedial activities.[37] All of the groups taking part in the monitoring program and recovery operations should regularly report data, results, and actions to this coordinating organization. Standardization of procedures among the different groups would facilitate the monitoring program.

5.1.5 After-Emergency Monitoring

Monitoring likely will be needed throughout the recovery period following a CAI. The monitoring effort can be divided into several distinct stages appropriate to the associated activities: an initial survey to identify, in gross terms, the extent and location of contamination; a control monitoring program associated with decontamination and remedial action activities; a monitoring survey to verify that areas can be released for reuse; and a postcleanup monitoring survey.

Planners should identify deployable monitoring, sampling, and communication equipment packages that meet the needs of the emergency and should make provisions for spares and maintenance. Points of contact and procedures to acquire these packages should be included in emergency plans and procedures.

5.1.5.1 Initial Survey Monitoring

Before a detailed monitoring program is started, initial survey (or screening) monitoring is normally needed to identify, in general, problem areas. This initial survey may have taken place entirely during the initial stages of the accident; however, further screening monitoring may be useful during the later stage of the accident before a detailed monitoring and sampling program is initiated.

5.1.5.2 Monitoring Instrumentation and Equipment

Currently available field monitoring instrumentation is described in a variety of reports and manuals and in the open literature.[17,42,43,56-58] A portable, hand-held real-time chemical agent monitor (CAM) based on ion mobility spectrometry has been developed in England and has been used in the United States over the past several years to detect chemical warfare agents, including blister and nerve agents.[59,60] A somewhat less portable chemical agent monitor (M8A1), based on the same ion mobility technique, is used to detect nerve agents only. Both detectors can be used to check personnel and equipment for gross-level contamination (i.e., in the range of 0.1-1.0 mg of agent/m^3). Two other detector kits (the M18A2 and the M256) are also used to detect chemical agents (nerve and blister agents) in the field. Tests with these kits take up to 10 minutes to complete.[40]

Equipment that detects chemical agents by gas chromatographic analyses is also available. The Depot Area Air Monitoring System (DAAMS) uses a portable glass tube filled with a collection material to collect samples wherever the necessary air pumping equipment can be set up. After sampling for a predetermined time at a known flow rate, the tubes can be analyzed in a laboratory by gas chromatography. This technique can determine type and quantity of agent if present at low concentration levels. The Automated Continuous Air Monitoring System (ACAMS) and the mini-CAM are automated gas chromatographs that provide real-time detection of blister agents, as well as nerve agents at low concentrations. This detection capability has been made somewhat mobile by outfitting a van so the equipment and associated gas bottles can be moved from place to place. Heated sampling lines allow sampling up to 100 feet from the gas chromatographic equipment.[40,56] More information on both gross-level and lower-level detectors, including sensitivities, is available in technical manuals and other reports.[17]

5.1.6 Sampling and Sample Analysis

Field sampling for contamination of air, soil, water, vegetation, structures, and other potentially contaminated articles will be required. Laboratory support for analysis of environmental sampling will need to be in place. Adequate methods now exist to sample for all agents in air.[39] Some analytical methods have been developed to detect unitary agents in environmental media. Methods of water and soil analysis are the most completely developed, but not all have yet received appropriate agency certification.[42,43] An analytical method has been developed for concrete.[42,43] No analytical methods have been developed for vegetation; however, some experimental procedures are under development for the quantitative determination of agent simulants (not yet for agents) in crop plants, grains, meat, and milk.[42,43]

5.1.6.1 Sampling Program

In general, the sampling program should include sampling of soils, air, water (including surface water), vegetation, and various structures within the contaminated zones.[54,61] Depending on the specifics of the accident, other types of sampling may be required.[4,49] Arrangements must be made to provide for suitably trained personnel equipped with appropriate monitoring and sampling equipment and supplies and suitable vehicles to conduct the sampling.

Sample design and protocols for monitoring of environmental media after the emergency will have to be developed, and a decision must be made as to who prepares the sampling protocols.[54] Sampling protocols must include consideration of the physical and chemical characteristics of the agent, and they should incorporate procedures for determining sample types, sample size, number of samples, preservation requirements, storage conditions, and where and how samples should be collected. Standardization of samples is important. Quality assurance, quality control, and chain-of-custody arrangements must be planned.[62-65] The sampling program must provide the basis for establishing firm statistical evidence of the presence or absence of chemical agent at predetermined levels. Sampling strategies must be established to determine if a contaminant is present and, if it is, to determine the mean concentration of that contaminant.

Leffingwell[66] discusses relevant statistical aspects of sampling strategy for reentry decisions. Sampling strategies should be developed for identifying and characterizing "hot spots." Accurate geographical information on sample location is important.[54] Therefore, development of a mapping capability in conjunction with the monitoring and sampling program is necessary to facilitate subsequent data interpretation and retrieval (see Section 5.1.7). Arrangements for storage and preservation of environmental samples will have to be addressed.[67] Appropriate labeling of samples will be needed (e.g., bar code labeling may be worth considering, particularly in cases for which large numbers of samples are anticipated).[49,54,68] DA Pamphlet 50-6[17] discusses types of sampling needed to determine the extent of contamination and the effectiveness of decontamination for emergencies.

Various protocols required will include sampling procedures, statistical sample methodologies for each area, type and number of samples for each area, data-recording procedures in the field, quality assurance procedures, and sample transportation.[54,69]

Organizational responsibility for sampling is outlined in a policy paper, CSEPP Policy Paper #2 on Environmental Sampling to Determine Agent Contamination.

5.1.6.2 Sample Tracking and Transport

Samples collected by trained sampling crews must be transported to laboratories for analysis and may be expected in the course of transport to be placed in temporary charge of couriers, pass into different vehicles, and perhaps spend time in temporary storage or sample reception facilities.[54] To ensure sample integrity, a chain of custody of the samples must be maintained. A decision must be made as to what organization will administer the chain-of-custody program. Arrangements may have to be made to maintain "cradle-to-grave" records on samples. Arrangements for ultimate disposition of samples also must be made.

Pursuant to EPA regulations [40 CFR 261.4(d)], a sample of solid waste or a sample of water, soil, or air that is collected for the sole purpose of testing to determine its characteristics or composition is not subject to any requirements of RCRA or to the notification requirements of Section 3010 of RCRA when the sample is being transported to a laboratory for the purpose of testing, is being transported back to the sample collector after testing, is being stored by the sample collector before transport to a laboratory for testing, is being stored in a laboratory before testing, is being stored in a laboratory after testing but before it is returned to the sample collector, or is being stored temporarily in the laboratory after testing for a specific purpose. The sample collector shipping samples to a laboratory and a laboratory returning samples to a sample collection must comply with U.S. Department of Transportation, U.S. Postal Service, or any other applicable shipping requirements, or if no promulgated shipping requirements apply to the sample, the shipper must assure that the sample is packaged so that it does not leak, spill, or vaporize from its packaging and that the following information accompanies the sample: (1) the sample collector's name, mailing address, and telephone number; (2) the laboratory's name, mailing address, and telephone number; (3) the quantity of the sample; (4) the date of shipment; and (5) a description of the sample. Once the sample is determined to be a RCRA hazardous waste and no longer meets any of the conditions set forth above, it must be disposed of as hazardous waste, following all requirements of RCRA.

5.1.6.3 Analytical Program and Laboratories

Access to suitably equipped laboratories with surety capability and the capacity to process potentially large numbers of samples of various types must be planned. Furthermore, the authorities in charge of sampling must establish a suitable method of deciding in a timely manner which sample is to go to which laboratory, and they must ensure that those decisions are communicated and implemented in a timely manner.

A mobile laboratory moved to the location of an emergency could enhance the speed of testing for time-critical samples and thus lead to more timely decision making. However, there are disadvantages, including the greater expense involved and the possible need for recalibration of equipment each time the mobile laboratory is moved.[39] It is anticipated that would be an Army activity, not a state or local responsibility.

Standardized analytical protocols need to be developed, and a decision must be reached about who is to write these protocols. Protocol approval to meet regulatory requirements must be addressed.[54] Training and certification for the laboratories must be planned. The analytical program protocol should cover laboratory receipt of samples, analytical methodology, quality assurance/quality control (QA/QC), and data reporting.[61,62] Analytical methodologies used should be subject to approval by EPA and USAEC. Additional regulatory agencies to be consulted could include, for example, the appropriate EPA regional office and the state health department.

Analytical methods, sensitivity, and quality are discussed in reports by the U.S. Public Health Service[39] and Watson and Munro.[4] An analytical procedures list for analysis of samples is provided in an appendix to DA Pamphlet 50-6.[17] It should be noted that a safe and professional sampling program requires experienced personnel, rigorous and frequent training, adequate funding, and a stringent equipment maintenance program.

5.1.7 Mapping and Sampling Sites

The location of each sampling or data point must be known accurately and unambiguously. Various mapping and sampling strategies are possible. One approach would be to develop a geographical coordinate grid system for the areas around the installation. This system would be useful in field monitoring, sampling, and decontamination activities. Identification of permanent benchmarks will aid in setting up such a grid. Decisions must be reached as to grid layout in various land use areas. Use of professional surveyors to establish the grid may be desirable.[69] Once a grid system is in place, the information should be encodable to support a database of information on the geographical distribution of contamination from the accident. However, a grid may not be the best way to determine the extent and levels of environmental contamination, and an intentionally biased sampling strategy that emphasizes sampling in low-dose areas, for example, may be preferable.

5.1.8 Sentinel Species

Various species of animals sensitive to chemical agents may be considered for use as sentinel species. Species naturally occurring in the area could be closely observed to provide warning of the presence of chemical agents.[4,39] Authorities may wish to consider such a program to provide a convincing supplement to analytical measurements of agent concentration. If a sentinel species program is to be conducted, decisions regarding species (native or introduced) must be made, animals acquired as needed, and animal care specialists or other appropriate personnel identified for this work. Animals likely to be considered as sentinel species include sheep, chickens, and pigeons, with house sparrows and starlings used as noncommercial sentinel species for monitoring larger areas.[68] Disadvantages of this approach include the concerns of animal rights groups. While the use of sentinel species is an approach that may be considered, it is not specifically recommended. The U.S. Army does not use, or consider using, animals as sentinel species.

5.1.9 Key Questions

The following key questions regarding the material in this subsection should be considered in the course of developing recovery, reentry, and restoration plans for a chemical weapons agent accident:

- How will environmental monitoring be done?
    - in what areas?
    - using what protocols?
    - using what documentation?
    - for how long?
    - by whom?

- How will samples be analyzed?
    - in what laboratories?
    - using what techniques?

5.2 PERSONNEL PROTECTION

5.2.1 General

A primary consideration for all recovery, reentry, and restoration activities is protecting the health of emergency workers and members of the general public. Thus, as part of normal emergency response planning, procedures for assuring such protection should be formulated in advance and adapted as needed should an accident occur. General information on health effects of exposure to chemical agents and on personnel protection against chemical agents may be found in various unclassified sources of information on chemical defenses.[57,58,70,71] Planning for the health and safety of emergency workers in general is discussed in the literature.[72-74]

This section briefly describes a number of possible methods of protecting personnel. During the planning process, consideration should be given to protective equipment; respiratory protection; protective clothing; personnel monitoring and decontamination; and protective ointments, antidotes, and other medical supplies. Authorities should plan to maintain records on and to provide suitable protective equipment and services for all regular and temporary emergency workers within their jurisdiction who will be operating in or near areas of an agent plume and/or liquid contamination. General aspects of this planning in the context of hazardous waste workers are discussed in the literature.[75]

Some key personnel protection issues remain unsettled. The only exposure guidelines presently available are Army guidelines for reducing acute exposure effects.[68] The potential for developing delayed effects (chronic bronchitis, carcinogenicity) from exposure to mustard agents is not adequately treated by acute-exposure guidelines. The Occupational Safety and Health Administration (OSHA) emergency worker protection standards and National Institute of Occupational Safety and Health (NIOSH) requirements would apply to off-post emergency workers who might respond to an accidental release incident. The Centers for Disease Control (CDC) is working with OSHA to develop acceptable protective clothing and equipment and will make its recommendations to the Army.

Protective equipment, clothing, and procedures for emergency workers will be addressed in upcoming planning standards for emergency worker operations. These standards will be incorporated as Appendix H to the *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*.[16] The standards are expected to identify protective clothing and equipment approved by OSHA and NIOSH for civilian responder use.

5.2.2 Protective Equipment

The use and selection of protective equipment requires specific training as mandated by OSHA regulations. Before any protective equipment is used, emergency workers must ensure that they are complying with all applicable OSHA regulations. Currently, the recommended personal protective equipment issue for CSEPP is under review. This information will be developed further as policy decisions are made on personal protective equipment.

A variety of protective equipment, in addition to normal safety equipment, would be needed during recovery from a CAI. Personal protective equipment in the related hazardous chemical waste context is discussed in the literature.[76] Specialized safety devices may be needed because of the special hazards created by a release of agent. In particular, portable instruments can be used to identify the presence and level of particular chemical agents.

This type of monitoring equipment should be made available to emergency workers who may be at risk of accidental exposure while working in contaminated areas. Field monitoring instrumentation for chemical warfare agents in this category is discussed in Section 5.1.5.2.

It is important that civilian response teams have some specialized equipment; it has been suggested that this equipment could include decontaminant such as high-test hypochlorite (HTH) (available commercially), M-256 kits, M-8 paper, or a chemical agent monitor.[77,78] State and local emergency service organizations might be able to use the local installation Defense Resource Management Office (DRMO) to obtain equipment;[77,78] however, because the DRMO normally deals with excess and sometimes outdated or unserviceable equipment, this approach may not be suitable.

5.2.3 Respiratory Protection

The use and selection of respiratory protection requires specific training as mandated by OSHA regulations. Before any respiratory protection is utilized, emergency workers must ensure that they are complying with all applicable OSHA regulations. Currently, the recommended respiratory protection issue for CSEPP is under review. This information will be developed further as policy decisions are made on personal protective equipment.

Respiratory protection can be provided by protective devices that remove harmful airborne gases, vapors, and aerosols from the air before inhalation (such as various forms of protective masks, including respirator filters against particulates and passive canister-type masks that remove a specific vapor or gas as it passes through the canister) or the direct introduction of noncontaminated air for inhalation (as in a self-contained breathing apparatus).

Arrangements should be made to provide for an appropriate quantity of suitable respiratory protection devices for emergency workers. Consideration should also be given to arranging for proper fit of respiratory protective equipment to individual emergency workers, as well as equipment maintenance. Training needs and the need to determine user fitness to perform necessary tasks while wearing respirators may also have to be addressed.

Respiratory protection in a chemical agent environment is discussed in a 1976 report by the Stockholm International Peace Research Institute (SIPRI),[79] as well as in Army publications.[58] Descriptions of available respiratory protection equipment suitable for use in the presence of chemical agents are provided in the Emergency Response Concept Plan reports for the posts involved in the Chemical Stockpile Disposal Program.[6-13] Long[57] describes respiratory protection equipment for chemical and biological warfare agent applications, and Rogers et al.[80] evaluate individual respiratory protection measures.

5.2.4 Protective Clothing and Associated Equipment

Arrangements should be made to have available an appropriate quantity of protective clothing and equipment for emergency workers. Stay time and duty/rest cycles for emergency response personnel wearing protective clothing should be established and incorporated into procedures. These procedures should be coordinated among response teams from different organizations. An adequate contingency supply of protective clothing and equipment should be available to allow personnel to change frequently and to allow for unforeseen clothing and equipment needs.

Information about protective clothing and equipment for use in chemical hazard environments may be found in various sources.[58,76,81] Physical countermeasures against chemical agents, including protective clothing, are discussed in the 1976 SIPRI report.[79] Protective clothing is described specifically in the context of chemical warfare agents are in the Emergency Response Concept Plan reports for the chemical weapons posts.[6-13] Various aspects of protective clothing and equipment for chemical and biological warfare agent applications also are discussed by Long[57] and by Rogers et al.[80]

5.2.5 Personnel Contamination Monitoring

Emergency workers (including monitoring personnel and other personnel involved in recovery work), and perhaps even members of the public, may work in or enter contaminated areas. It is important to determine the extent to which these individuals have been exposed to chemical agents, both for medical and personnel protection reasons and for legal reasons, so that further occupational exposure can be kept within guideline levels. Thus, a regular check needs to be made on the extent of exposure of emergency workers to chemical agents, and appropriate records should be kept. A report on medical screening guidelines is available.[82]

5.2.6 Decontamination of Personnel

Briefings and other communications to all emergency personnel should emphasize that contamination avoidance should be practiced at all times. However, provision must also be made for the decontamination of any personnel accidentally contaminated with chemical agent. This activity will require equipment, supplies, trained personnel, and identification of suitable locations to establish personnel decontamination centers. Decontamination for emergency workers at the work site and on exiting the potentially contaminated area could be provided by mobile decontamination units that could be moved to appropriate locations such as central access points. In addition, some need for decontaminating capability might also be anticipated at fixed facilities such as hospitals.

Personnel decontamination is discussed in a number of reports, including DA Pamphlet 50-6,[17] guidance prepared for the Department of the Army and FEMA,[16] and a report by Long.[57] Army personnel decontamination station standards for construction, operation, and contamination control are specified in FM 3-21 and AMC-R 385-131.[77,78]

Procedures for decontamination of people are included in planning standards for response phase decontamination, which have been incorporated as Appendix L to the CSEPP planning guidance document.[16] Planning standards for emergency worker operations will include provisions for decontaminating civilian emergency workers.

5.2.7 Prophylactic Measures

Prophylactic drugs are drugs that can be administered before exposure to nerve agents in order to prevent or mitigate agent effects. No plans currently exist to use prophylactic drugs among civilian populations.[83,84] Prophylactic drugs are discussed in the Emergency Response Concept Plan reports for the various posts and their vicinities.[6-13] Protective skin ointments and barrier creams are discussed in the reports by SIPRI[79] and Rogers et al., but they are not currently available either for military or civilian use.[80]

5.2.8 Antidotes

Antidotes are drugs intended to prevent, relieve, or otherwise counteract adverse effects resulting from agent exposure that has already occurred. Antidotes against nerve agents in current use are atropine and pralidoxime, which must be administered within minutes after exposure, preferably intravenously or by injection into a major muscle. Military kits are available containing a pack of two spring-loaded auto-injectors, which, when actuated against a large muscle, will automatically eject hypodermic needles. One will inject atropine and the other pralidoxime. Supplemental use of diazepam (Valium) in conjunction with these drugs has been recommended.[85] Adequate supplies of antidotes and suitable training in their use should be planned for in the event of a CAI.

Antidotes are discussed in the Emergency Response Concept Plan reports for the various posts.[6-13] First aid procedures for chemical agent exposure are described in several reports, including References 57, 80, and 84. The medical screening guidelines may also be consulted.[82]

5.2.9 Medical Issues

Provisions should be made to treat casualties and to deal with the medical problems of emergency workers.[75] Methods for the treatment of casualties from some agents have appeared in the open literature since before World War II,[86] and there is significant contemporary literature.[87,88] For example, general aspects of medical protection against chemical warfare agents are discussed in the SIPRI report,[79] and a recent technical memo on this subject was used to brief servicemen and women on medical issues of agents before Operation Desert Storm.[85] U.S. Air Force tactical air command air-transportable hospitals, such as those set up in Saudi Arabia in support of Desert Storm operations, are capable of treating victims of chemical agents and possibly could be made available in the event of a chemical agent accident.[89] Medical surveillance in the hazardous waste context is discussed by Melius.[75]

Plans should be in place to provide for the prompt decontamination of injured personnel in order to expedite their evacuation to a treatment facility. Provision should also be made for the possibility of heat stress in emergency workers wearing protective clothing against chemical agents.[90]

5.2.10 Procedural Considerations

An emergency worker protection planning checklist is provided in the planning guidance for the CSEPP.[16] The checklist will be specified in considerably greater detail by the upcoming planning standards for emergency worker operations.[16] Planning to protect health and safety in general at sites of hazardous chemical accidents; to ensure the availability of respiratory devices, special protective clothing, facilities for decontamination of exposed protective clothing, and other response equipment; and other related topics is discussed in FEMA's *Handbook of Chemical Hazard Analysis Procedures*.[72] Reference 85 should also be consulted.

5.2.11 Key Questions

The following key questions regarding the material in this subsection should be considered in the course of developing reentry, restoration, and recovery plans for a chemical weapons agent accident:

- How will personnel contamination monitoring be done?
  - for which persons or population?
  - by whom?
  - using what protocols?
  - for how long?
  - using what documentation?
- What kind of protective equipment will be used under what circumstances?
- Who will control issuance and maintenance of equipment?
- What decontamination procedures for personnel will be used?
  - where will this activity be done?
  - who will perform it?
- What advance authorization will be needed for buying, transporting, issuing, and administering antidotes and prophylactic drugs?

- What are the procedures for administration of drugs?

- What quantities of antidote and prophylactic drugs are estimated to be needed for a given location?

- What assurances have been made that the quantity is available?

5.3 ACCESS CONTROL AND REENTRY

5.3.1 General

Protective measures might be required for considerable periods following contamination of an area by an accidental release of persistent chemical agents in particular. The purposes of restrictions on land use, control of access, and complete closure can be summarized as follows:[37,69]

- Prevention of unnecessary exposure of persons to contamination;

- Prevention of unauthorized reentry and maintenance of the security of temporarily abandoned property until it can be recovered or decontaminated; and

- Prevention of unauthorized transfer of contaminated products or articles to uncontaminated areas, leading to the risk of persons in those "clean" areas being exposed to contamination, either directly or by exposure to contaminated food or water.

If these purposes are clearly understood by the public, the restrictions are more likely to be accepted.

5.3.2 Definition of Areas Requiring Access Control

Decisions as to which areas are to be initially restricted will normally have been made during the early emergency response phase of the accident, and the restricted areas will have been marked off and secured. It can be anticipated that initial restrictions may subsequently be relaxed to some extent as monitoring indicates that areas are not contaminated. However, the possibility remains that outlying "hot spots" may be discovered somewhat later and that additional restricted areas may have to be established.

Before detailed monitoring is undertaken, it may be necessary to conduct screening monitoring to find out where the problems really are and then mark off and secure these areas. Some well-defined method of marking off the areas is needed (e.g., red flags and tape on a temporary basis for smaller areas), and responders need to be informed of the method of marking (for recognition as well as implementation purposes) and what it signifies in terms of agent and safety levels.

5.3.3 Implementation of Access Control

Ideally, ingress to and egress from restricted areas should be through access and traffic control points or stations provided with monitoring equipment and decontamination equipment. However, according to the current draft versions of planning standards for traffic and access control, the control points will not perform monitoring and decontamination. The control personnel should have legal authority to deny access to the area. Consideration may be given to the need for security fences or patrols, as well as warning signs.[48] Although the public will have been informed of restricted areas earlier in the accident, additional media announcements and instructions will also be needed during the later phases of the accident (as is discussed in more detail in Section 5.8).

Access to an area from which the residents have been evacuated or relocated should be controlled and entrance allowed only for persons engaged in essential activities. These people include emergency workers (e.g., monitoring teams and teams engaged in recovery and decontamination efforts) and personnel conducting essential activities within the affected area (such as farmers or caretaker teams entering to care for livestock or workers required for industrial operations that might become dangerous without continuous surveillance).

In certain areas of the restricted zone, it might be necessary to prevent all members of the public from entering to take up normal residence until the affected areas had been adequately decontaminated. In other parts of the restricted area, controlled access of workers might be considered for industrial, agricultural, or other commercial purposes. Situations might occur in which the potential for exposure to agent might be too high for permanent residential use for families, but it might be below occupational limits for fixed-duration working periods.

While security forces at access control checkpoints will be in a position to exercise control over the removal of potentially contaminated items past these checkpoints, there may remain a wide perimeter not under positive control. Off-road vehicles and pedestrians may be inhibited from entering the area by perimeter fencing. However, there remains the possibility that contaminated materials may be transported across the boundaries by other mechanisms, such as wind and water erosion and the movement of wildlife.

5.3.4 Interdiction of Restricted Areas

Interdiction refers to complete or partial restriction on the use of land or property for a period of time. Interdiction is to some extent a form of access control. During the earlier stages of an accident, ingress and egress would be controlled by security personnel. During the later stages of the accident, authorities may decide to interdict all or part of the restricted area for long periods if a determination is made that cleanup of these areas is not immediately practical or economically feasible.[48,69] For example, if the cost of decontaminating an area and disposing of the wastes greatly exceeds the property and commercial value and relocation costs, authorities may decide to interdict the area until natural degradation processes reduce agent concentrations to acceptable levels.[34] Authorities may also decide to interdict areas that are part of a fragile ecosystem, such as a desert, that could be irreparably damaged by decontamination efforts.[37]

The cost of interdicting an economically important area could be very high, and it might be less expensive to decontaminate such an area than to interdict it for long periods, unless the area is badly contaminated. On the other hand, the interdiction of limited-use areas such as deserts, some forested areas, mountainous areas, and wetlands, could involve only small economic penalties.[48,69] Establishment of a National Defense Area might offer a mechanism for accomplishing such interdiction.

5.3.5 Personal Property

Articles removed from a contaminated area should be certified as agent-free or be disposed of in an environmentally sound manner. This process will require procedures for monitoring and sampling, temporary holding arrangements, and an officially accepted certification process and the associated documentation. If environmental monitoring shows that articles in evacuated areas were not in contact with the agent, they might not require testing, although testing might be desirable to restore public confidence and enhance peace of mind.[39]

5.3.6 Security in Restricted Areas

Initially, security might be provided primarily by military personnel, with some police involvement; however, during later phases of the accident, some security operations would be transferred to state and local police from the affected communities, perhaps supplemented by additional security personnel. Procedures need to be developed for such a transition from Army to civilian security forces.* Since security personnel from different organizations may be involved, arrangements for coordination and communications, perhaps as a function of the Emergency Operations Center, will be needed. It would be helpful to responders if procedures of the different responding organizations were compatible. Planning for the security of evacuated hazard zones is discussed in the *Handbook of Chemical Hazard Analysis Procedures*,[72] as well as in DA Pamphlet 50-6, Chapter 5.[17]

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* There are various mechanisms and sources of authority for deployment of military personnel to effect security outside the installation; there are also legal restrictions on so doing. A useful reference on this topic is a draft paper entitled *Chemical and Nuclear Weapons Accident Legal Issues*, by S.R. Citron, Attorney-Advisor, HQ-DESCOM, Chambersburg, Pennsylvania.

5.3.7 Reentry into Potentially Contaminated Areas

5.3.7.1 General

The term "reentry" is used here to refer to temporary entry of persons into a restricted zone under controlled conditions (restricted return to potentially contaminated areas), as well as to controlled return to a previously evacuated area (return for permanent, unrestricted use). Generally speaking, even with respect to other, more familiar types of emergencies, solutions to the problems associated with reentry after evacuation are not well characterized. Past experience in other types of emergencies suggests that reentry can be riddled with problems; this area will need particular attention in advance.

Following a CAI, it will be very important to be able to tell evacuees whether they may return to their residences, or whether they must remain in temporary accommodations or mass care facilities. Once reentry policies have been established, those policies need to be well communicated, well understood, and consistently applied.

5.3.7.2 Conditions for Reentry

During the earlier stages of the accident, the population of the affected area presumably will have been evacuated. (Although it is possible that some people may shelter in place because of proximity to the point of origin, even those people will probably have to be evacuated once the contaminant plume has passed their location.[83]) Civil authorities must establish conditions and criteria for reentry and develop appropriate procedures for implementing the reentry process. Immediately after the accident, there may be an initial period of quarantine when entry to the affected area will be denied except to emergency workers determining the extent of contamination through a monitoring and sampling program.

In areas in which no contamination is found, restrictions could be lifted and arrangements made for evacuee return. It has been suggested that evacuees should be permitted to reenter such areas in a phased manner, beginning with the areas least likely to have been contaminated.[39] If contamination is encountered, decontamination must be completed and thorough monitoring and sampling conducted before reentry should be considered. Guidelines on conditions under which reentry should take place are presented in the U.S. Public Health Service's report *Results of a Workshop Meeting to Discuss Protection of Public Health and Safety During Reentry into Areas Potentially Contaminated with a Lethal Chemical Agent*.[39]

5.3.7.3 Reentry Intervals

One regulatory measure that could be taken to mitigate the toxic effects of chemical agent residues in the aftermath of an accident would be to establish minimum times of exclusion, or minimum reentry intervals, to forestall return into contaminated areas before natural decontamination processes will have rendered the areas safe for unprotected individuals. This approach has been used in the related situation of reentry into areas treated with pesticides, as discussed in Section 2.4. Establishing minimum estimated times of exclusion has a useful purpose for planning and letting the public know what they need to prepare for. (The final decision to reenter should be made on the basis of field sampling.) So the exclusion intervals will be longer rather than shorter than the minimum times of exclusion.

The EPA experience with reentry data indicates that it would be best not to rely entirely on a reentry interval for safety after an accidental release of any of the chemical warfare agents. Reasons for this conclusion are that establishment of a reentry interval assumes both that the application rate for any given contaminated area is known and that the rate of dissipation of the residues is known for that site (or alternatively that a worst-case rate is used for the calculation). Residue dissipation is a result of a combination of chemical reactions (e.g., hydrolysis, photolysis, and oxidation) and of physical processes (e.g., volatilization and runoff). All of these processes are affected by the environmental conditions at the site of release. Those conditions can vary from site to site, from time of year to time of year, and even from day to day. The truly limiting factor is that initial amounts of residue are not known and will vary widely. Without a starting residue level, estimation of a reentry interval is impossible. Thus, the use of reentry intervals in response to a CAI would be particularly problematic. The material in this subsection is presented simply to provide an overview of an option that may serve as a stopgap measure until a complete set of reentry levels and the necessary sampling and analytical methodology have been developed and adopted.

Generally speaking, until evidence confirming safety is in place, it would appear prudent for civil authorities to designate a relatively long minimum time before persons not wearing protective masks and protective clothing would be allowed to enter a potentially contaminated area. Minimum times ranging from 48 hours for GB to 14 days for VX and mustard have been suggested, with maximum times of up to 2 weeks for GB and 90 days for VX and mustard.[39] Reentry intervals and times of exclusion are discussed in the report *Reentry Planning: The Technical Basis for Offsite Recovery Following Warfare Agent Contamination*.[4]

Time delays in reentry associated with implementation of monitoring and sampling need to be considered. Monitoring and sampling can be initiated very rapidly; however, responders would need, at the very least, several days to assemble the necessary trained personnel and equipment and to conduct the monitoring and sampling and obtain adequate analytical results to be able to assure a safe return for evacuees. The time required to test and certify safety will vary with the area affected and the agent involved. It has been suggested that, for a release of GB (the simplest case), a minimum wait of 5 days should be anticipated before all potentially affected areas could be certified safe.[39] Actual times might be much longer, depending on the agent and the circumstances of the release.

5.3.7.4 Reentry Levels

A safer alternative to establishing reentry intervals would be to establish reentry levels for each agent and not to allow reentry until tests show that the existing residue levels are less than the established reentry level. Reentry levels are independent of the rate of dissipation and, therefore, are general for all of the possible sites. Perhaps transfer coefficients can be used to achieve this goal. Disadvantages of this procedure are that suitable field test methods would have to be developed and used and field test personnel would have to be trained and available. Acceptable levels for residual contamination have not yet been developed.

To minimize unnecessary or premature field testing, a sentinel animal could be used, for example, ubiquitous birds such as house sparrows. The presence of healthy living individuals of a sentinel species could be used as a biological indicator. Introduction of sentinel organisms could help determine the extent of agent contamination. Alternatively, intervals might be established for delay before the start of testing (monitoring and sampling). These intervals would be based on known rates of reaction and known rates of volatilization with the environmental conditions existing at the location. It should be stressed that such an interval would not be useful for the reentry of unprotected humans into contaminated sites.

5.3.7.5 Reentry Planning

Proposed reentry decision criteria are given in the executive summary of the appendix of the CSDP FPEIS.[3] Information on reentry planning also is discussed in 1990 reports by the U.S. Public Health Service[39] and Watson and Munro.[4] Both restricted return to potentially contaminated areas and return for permanent, unrestricted use are discussed in those publications. Planning standards will be discussed in a forthcoming appendix (Appendix M) to Reference 16.

5.3.8 Key Questions

The following key questions regarding the material in this subsection should be considered in the course of developing reentry, restoration, and recovery plans for a chemical weapons agent accident:

- How should access control be administered?

- How should reentry be conducted?

  - when?
  - for whom?
  - for how long?
  - in which areas?
  - under what circumstances?

5.4 INGESTION PATHWAY CONSIDERATIONS

Because ingestion of even small amounts of chemical warfare agents may lead to adverse health consequences, it may be necessary to exercise control over drinking water and human food and the human food chain. The planning process requires consideration of detecting the agent released, controlling agricultural products, and controlling water supplies. Recommendations for community emergency planning with respect to water, foodstuffs, livestock, pets, and crops have been made in References 4, 39, 42, and 43; information on ingestion pathway considerations for other types of accidents is available in the literature (e.g., References 91-94).

5.4.1 Detection of Chemical Agents in Food and Water

Detection of the presence of chemical agent in food and water supplies would normally be handled under the monitoring and sampling program. The Army has had treatment-control water-testing kits for mustard agent and some other agents since 1944, and a food-testing kit for mustard agent and some other agents since 1945.[95] Information on monitoring and sampling the ingestion pathway in other types of emergency is discussed in reports by the International Atomic Energy Agency (IAEA)[55] and by FEMA.[96,97] Further information is also presented in References 42 and 43.

5.4.2 Control, Decontamination, and Disposition of Potentially Contaminated Food and Agricultural Products

The protection of food, crops, and livestock against chemical agents has been investigated at least since the large-scale introduction of chemical weapons, and various methods have been devised and discussed in the open literature.[95,98] Responsibility for dealing with contaminated foodstuffs should be clearly defined in advance of any accident. The responsibilities and authority of state and local governments to seize, hold, and condemn food that may be contaminated should be clarified as needed for the preparation of procedures. Any organizational structures and the associated staffing for dealing with contaminated foodstuffs in an emergency should be in place and adapted as needed for chemical agent emergencies. Planners can expect to work with the EPA, Department of Agriculture, and Food and Drug Administration on these issues.[4,99]

Protection and decontamination of agricultural resources is discussed in some detail in a report by Watson and Munro,[4] and guidelines with respect to crops, dairy products, and stored food have been prepared by the U.S. Public Health Service.[39] Experience has been gained in controlling the distribution and consumption of contaminated foods in other types of emergencies.[100]

5.4.3 Control of Contamination in Water and Water Supplies

The protection of water supplies against chemical agents has been investigated at least since the large-scale introduction of chemical weapons, and various methods have been devised and discussed in the open literature.[95,98] During the early emergency phases of the accident, initial controls should have been instituted to prevent the use of potentially contaminated water. These controls would include restriction of human use, farm and agricultural use, and industrial use of contaminated water. These restrictions may have to be modified during the later phases of the accident. Further information regarding restrictions on the use of water and sources of assistance for hazardous chemical accidents may be found in a report by the U.S. Department of Transportation.[81] Chemical agent hazards in public drinking water supplies could be at least in part eliminated by increasing chlorination.[83] Private water supplies are problematic, but might be dealt with in the short term by bringing in alternative supplies of water.

Control of potentially contaminated water supplies in most cases includes shutting off water supply intakes at the contaminated source, or possibly filtering or otherwise cleaning the water at the point of intake into the distribution system.[37,48] To avoid potential contamination of the groundwater and surface water in areas from which water supplies are drawn, it may be necessary to construct a series of temporary hydraulic engineering structures.[37,48] If a water supply must be cut off for more than a few hours, alternative sources of water must be found and provided for drinking and cooking, other domestic uses, fire fighting, and any essential industrial uses, as well as for decontamination.

5.4.4 Considerations Relating to Livestock

Protection, decontamination, and veterinary diagnosis and treatment of livestock are topics that need to be addressed.[4,101] Guidelines with respect to care of livestock may be found in an Army publication.[58] Some consideration may have to be given to game animals also. Plans may be needed for disposal of animal carcasses.

5.4.5 Procedural Considerations

Planning for provision of alternative water supplies, postemergency testing for contamination, movement and care of domestic livestock and pets, and other related topics are discussed in the *Handbook of Chemical Hazard Analysis Procedures* and other reports.[4,58,72]

5.4.6 Key Questions

The following key questions regarding the material in this subsection should be considered in the course of developing reentry, restoration, and recovery plans for a chemical weapons agent accident:

- Who will be responsible for inspecting, seizing, holding, condemning, or destroying contaminated foodstuffs?

- How should agricultural products be controlled?

  - which crops to harvest or destroy?
  - how to decontaminate?
  - what to allow on market?
  - when?
  - from which areas?

- How should agricultural advisories be issued?

  - when?
  - to whom?
  - for how long?
  - what to advise?

- What restrictions should be placed on water?

  - where?
  - for how long?
  - for what use?
  - how to treat?

- How will alternative sources of water be obtained?

- What penalties, if any, will there be for noncompliance?

5.5 DECONTAMINATION, CLEANUP, MITIGATION, RESTORATION, AND REMEDIATION

5.5.1 General

The National Contingency Plan mandates a detailed procedure for conducting remedial actions, including a site inspection, a remedial investigation and feasibility study, a record of decision, and the remedial action step itself. The procedure is discussed in more detail in Section 4. The procedure is also reviewed in detail in DA Pamphlet 50-6, which provides further information on contamination control, decontamination, and remedial actions.[17]

Decontamination will be an important means of coping with the effects of the release of a chemical agent from a stockpile accident. In some cases, it may be necessary to decontaminate personnel, as well as buildings, equipment, vehicles, and the terrain. The problems involved will include time factors, supply of decontaminants and decontamination equipment, personnel capabilities and skills, and economic factors. Decontamination will be a complex operational and logistical effort, especially in the case of large-area contamination with nerve agents.

Decontamination with respect to chemical agents has been investigated and reported on at least since the large-scale introduction of chemical warfare. Information is provided on decontamination in the context of chemical defenses in various unclassified literature.[4,34,70,87,102] Decontamination also is discussed in the CSEPP planning guidance.[16,103] Steps to be taken in the event significant contamination is detected are outlined in Reference 58. Extensive literature also exists on decontamination and remedial actions in general for chemically contaminated sites (e.g., References 32, 33, and 104). Further analyses of issues relating to decontamination are needed. At present, no good way exists to measure the degree of decontamination and to determine "how clean is clean" for vegetation and porous media such as wood, plastics, and masonry.[42,43] Furthermore, recommendations for maximum chemical agent control levels currently extend only to the air and water concentrations.[4,99]

5.5.2 Existing Guidelines on Decontamination

At this writing, Army guidelines require "5X" decontamination before release of contaminated material for civilian use. The 5X level is one of the categorical classifications of decontamination used by the U.S. Army to govern agent decontamination of material.[58] An item is considered 5X when it has been decontaminated to the "no-effects" level with procedures that are known to destroy the agent molecule. The necessity of going to 5X by using the usual heating temperature-time protocol for agent destruction before releasing an item to the public is under review, and possible modification of these guidelines is under study by the Office of the Surgeon General (Army).

5.5.3 Characterization of Affected Area before Restoration

Before decontamination or other restoration activities begin, it would be valuable to have the area thoroughly characterized. This characterization would provide an overview of the potentially contaminated area, as well as of its unique characteristics. Site characterization should minimally include those elements listed in Table 2 and should be in sufficient detail to address the following needs:[4]

- Identification of all possible sources of potential interference (particularly false positives) with analytical determination of agents in environmental media. Estimates should be made of anticholinesterase agricultural pesticide use (organophosphates and carbamates), and the locations of crop fields, herds, etc. where such pesticides are used should be identified. Factories, warehouses, commercial outlets, and other locations where anticholinesterase compounds are handled or dispensed also should be identified.

- Establishment of site- or region-specific normal ranges of baseline cholinesterase activity levels, by use of an acceptable analytical protocol, for livestock species of commercial importance, companion animals such as dogs and cats, and any animals likely to be used as sentinel species. Sources of normal variability need to be addressed.

- Identification and location on appropriate maps of the likely locations of contamination if dense, low-volatility persistent compounds such as VX or sulfur mustard agent are released.

In addition to the general characterization of the contaminated area and items, the extent of contamination needs to be thoroughly characterized by the monitoring and sampling program. Environmental measurements should include the distribution and concentration of agent in all significant environmental media throughout the affected area.

5.5.4 Alternatives to Decontamination

Since decontamination will be expensive and, under existing guidelines, destructive to most property (see Section 5.5.2), alternatives should be considered. One approach could be to avoid unnecessary decontamination by developing improved methods of establishing and certifying that objects or materials were never contaminated to begin with. If time is not of the essence, a feasible alternative to conducting decontamination might, in some instances, be reliance on long-term natural degradation and decontamination processes, such as (for example) by interdicting areas not normally frequented or used by the public, such as remote desert areas or wildlife preserves.[4] Condemnation and buyout is another alternative. Economic considerations may be important in deciding whether to rely on condemnation and natural detoxification or to conduct decontamination. It may be necessary to clarify who makes the decision to conduct decontamination.

TABLE 2 Essential Elements for Site Characterization

Element	Components
Demographic data	Population distribution Total population
Land use data	Industrial Agricultural Residential Food and drinking water supplies Property values
Terrain	Forests Wetlands Prairie Desert Topographic features Surface types
Constraints	Endangered species Monuments Historic landmarks

Source: Adapted from Reference 40.

Natural processes can be used as a substitute for deliberate decontamination. These natural processes include the action of wind, solar radiation, humidity, rainfall, biological systems, and soils. It is common practice to let contaminated items aerate to "weather" them, and, at a minimal level of decontamination activities, to cover contaminated areas with clean soil or to use local water for washing operations.[34] The efficiency of natural detoxification processes depends on meteorological conditions and on characteristics of the contaminated area itself (such as pH of the water and mineral composition of the soil). This process is discussed in some detail by Trapp.[34]

If natural decontamination (weathering) is to be employed, it will be important to obtain information on how long it will be necessary to hold or impound objects or materials to allow for agent degradation or natural detoxification. Some information on this topic is available from Trapp;[34] if quantitative information is not available, indefinite quarantine may need to be considered.[54]

5.5.5 Decontamination Methods, Techniques, and Equipment

Decontamination methods, techniques, and equipment are discussed in the unclassified literature on chemical weaponry (e.g., Reference 70). Decontamination methods are discussed in some detail in *The Detoxification and Natural Degradation of Chemical Warfare Agents*.[34] Decontamination of buildings, personal property, and agricultural resources is discussed in *Reentry Planning: The Technical Basis for Off-site Recovery Following Warfare Agent Contamination*.[4] Decontamination information also is presented in *Interim Guidelines for Reentry into Areas Potentially Contaminated with Lethal Chemical Agent*,[58] and planning for cleanup of dead livestock and wildlife is discussed in *Handbook of Chemical Hazard Analysis Procedures*.[72] Various mechanical, physical, chemical, and biological decontamination methods are discussed by Trapp,[34] and chemical agent decontamination is also described by Long.[57] Army methods are described in Army Materiel Command Regulation 385-131.[58] Planning standards for decontamination are provided in Appendix L ("Planning Standards for Decontamination for the Chemical Stockpile Emergency Preparedness Program") of Reference 16.

The Army's standard decontamination solution 2 (DS-2), described as the Army's decontaminant of choice and as the most effective multipurpose decontaminant for a broad range of potential chemical agents encountered, has been criticized as too toxic and too destructive of the equipment it is intended to decontaminate.[105] Improvised substitute decontaminants for use in situations in which adequate supplies of standard military decontaminants are unavailable, and potentially safer alternative decontaminants such as bleach, are discussed by Trapp[34] and Long.[57] General cleanup technology for accidents involving hazardous substances may have a limited applicability in these circumstances.[106]

5.5.6 Disposition and Disposal of Decontamination Wastes

Arrangements will have to be made for the transport and disposal of wastes from decontamination.[54] The costs of loading, transporting, and disposing of wastes arising from the decontamination of large contaminated areas may constitute a significant fraction of the total costs of an accident.[48,69] Optimally, these operations should be accomplished not only to minimize the potentially large costs, but also to reduce the occupational exposures to the cleanup workers and possibly to others.

Considerable knowledge has accumulated on the safe transport and disposal of large volumes of material contaminated with radioactivity.[37,69] While CAI decontamination methods will be very different, this experience may be helpful in general terms with respect to methods and techniques available to ensure that such operations are accomplished properly and efficiently.

Some states classify used decontamination solution as hazardous waste. Planning for disposal of hazardous wastes following a hazardous chemical spill is discussed in the *Handbook of Chemical Hazard Analysis Procedures*.[72] Coordination with the Army will be needed in chemical agent disposal.[58,107]

5.5.7 Planning for Decontamination, Restoration, and Remediation

To minimize potential adverse effects to the environment from a chemical accident causing serious contamination of large areas, plans should be developed for emergency cleanup following the accident. Optimally, preparations for cleanup should be accomplished in two phases: (1) preliminary planning done as a part of normal on- and off-post emergency preparedness for each installation, and (2) the final detailed planning and assessment that would be initiated at the onset of the accident and that would take into account accident-specific information. These plans would be complementary and both should contain an overall operational plan and technical information on suitable equipment and procedures required to carry out the cleanup safely, efficiently, and with minimal costs.

These plans must provide for decontamination of a wide range of areas and items, such as large land areas, forested areas, aquatic ecosystems, paved surfaces, vehicles, various types and sizes of equipment, exteriors and interiors of buildings, crops, foodstuffs, and water supplies.[4,34,48] Contaminated living and dead livestock, pets, and wildlife may require attention.[4] Some members of the civilian population and emergency workers may need to be decontaminated, as may the remains of any individuals who die during the course of the accident and its aftermath.[4] Clothing and personal possessions may require decontamination. It is clear that very different approaches to and methods for decontamination will be needed for these different applications, and different approaches have been developed.[4,34,70] Procedures appropriate to these various approaches and methods for decontamination of different types of objects also will need to be developed. Much of the necessary information may be available from site characterization studies conducted in advance of any accident.

5.5.7.1 Preliminary Planning

Preliminary cleanup plans should be developed that contain generic information applicable to on- and off-post decontamination and remediation efforts for all installations, as well as site-specific information applicable to a particular installation. Generic information that could be relevant to all installations would include the following:[48]

- Technical information on characterizing the contamination (Sections 5.1 and 5.5.3 of this document), cleanup equipment and techniques (Section 5.5.5), and means of disposal of decontamination wastes (Section 5.5.6);

- Criteria for reaching a decision to conduct a cleanup, criteria defining the specific agent levels that must be achieved by decontamination and remediation activities, and final criteria for the release of all or part of the area for unrestricted or restricted use to allow the return of the population, reuse of the land for agriculture, etc. (including ARARs) (Section 4.1.5.1);

- Information on the subplans (for monitoring and sampling, data management, quality assurance, emergency worker protection, compliance with criteria, etc.) and procedures required to carry out a large-scale cleanup; and

- Assessment of relevant equipment, facilities, and other resources available both locally and nationally, with contact information.

In addition, specific information for the area surrounding the installation should be included in the preliminary plan and procedures documentation. This information should include:

- Details on the types and amounts of agents present at the installation that might be released in the course of an accident, together with whatever information on munitions and characteristics of storage and release scenarios that could provide information on the chemical/physical form and distribution of anticipated contamination (information in this category is contained in the FPEIS[3] and site-specific EISs being developed);

- Characteristics of the affected area (Section 5.5.3);

- Monitoring and sampling plan (Section 5.1);

- Information on a geographical coordinate grid system for the area around the installation so that the location of each sampling or data point is known accurately and unambiguously for characterization of contamination and implementation of decontamination; and

- A data management system (Section 5.9).

5.5.7.2 Later Planning Considerations

Before any major decontamination effort is started, the preliminary planning should be reviewed and updated in the light of new information, and an implementation plan should be developed. This plan should do the following:[38]

- Specify who is financially and technically responsible,
- Identify what is to be done,
- Establish schedule for completing tasks,
- Specify procedures for certification that cleanup criteria are met,
- Develop registry of contaminated and potentially contaminated persons, and
- Consider desirability of long-term public health study/medical monitoring program for contaminated and potentially contaminated persons.

If a decision is made to employ cleanup contractors, planning for the extent of the work to be delegated to contractors and for supervision of the contractors, as well as negotiation of contracts, must be considered.

If satisfactory decontamination is to be achieved, a wide range of site-specific factors must be considered in development of the decontamination process:

- Agent involved,
- Type of material (concrete, asphalt, metal, wood, soil, etc.),
- Type of surface (porous, rough, smooth, coated [e.g., with paint or plastic]),
- Established efficiency of the process, and
- Extent of decontamination required.

Other factors that may be of importance in selecting the method but that would not directly affect the extent of decontamination, could include the following:[37,48]

- Availability, cost, and complexity of the decontamination equipment;
- Availability of trained staff;
- The need for treatment of decontamination wastes;

- Potential occupational and public exposure resulting from decontamination;

- Further safety, environmental, and social issues; and

- Extent of need for subsequent decontamination of the decontamination equipment.

Selection of the decontamination process may depend on the best balance among such factors as those listed above in order to minimize the overall impact and net detriment to people with the most cost-effective means. Section 5.5.5 discusses methods available for decontamination and some of the relevant experience with those methods, together with references to more detailed information on decontamination methods for chemical warfare agents.

Planning for decontamination and cleanup for analogous situations following nuclear accidents is discussed in further detail in References 48 and 69. Many of the general principles discussed in those reports will apply to chemical accidents as well. A decontamination planning checklist is included in the *Planning Guidance for the Chemical Stockpile Emergency Preparedness Program*.[16]

5.5.8 Record Keeping and Reporting

Some of the decontaminants used in cleaning up a CAI site may themselves be capable of adversely affecting the environment. As a consequence, appropriate reports must be filed with regulators. Hence, information must be collected and recorded to assist in the after-action environmental reporting and cleanup. Current environmental regulations require that reports be filed when 10 pounds or more of high-test hypochlorite and/or Super Tropical Bleach (STB) is applied; the report must include the location where the material was applied and the amount of water used, to the nearest hundred gallons.[77,78] In addition, records will likely be needed of all items decontaminated, the method and extent of decontamination, postdecontamination monitoring results, and any certification papers issued. Plans and procedures for such record keeping should be established.

5.5.9 Key Questions

The following key questions regarding the material in this subsection should be considered in the course of developing recovery, reentry, and restoration plans for a chemical weapons accident:

- Who will coordinate and supervise decontamination activities of multiple organizations and contractors?

- How will the need for decontamination be determined?

- Who will perform the cleanup procedures?

- How will analysis be done?

  - what standards will be used?
  - how will records be kept?
  - to whom will records be accessible?
  - how will differing interpretations be resolved?
  - how will samples be distributed among laboratories?

- What levels of decontamination should be achieved?

  - for people?
  - for the environment?
  - for housing and possessions?
  - for animals?
  - for human remains?

- What are the priorities for decontaminating equipment, components of the environment, etc.?

- What qualifications will be required of personnel?

- What certification will there be that cleanup criteria are met?

- Who has responsibility and authority for impounding potentially contaminated personal property?

5.6 RELOCATION NEEDS AND RESOURCES

5.6.1 General

The term relocation is generally used to describe that process whereby people are moved from an endangered or contaminated area after the immediate emergency has passed. Relocation may be either temporary or permanent, depending on specific circumstances. It should be noted that temporary relocation facilities have a tendency to become permanent residences in the absence of proper planning.

5.6.2 Potential Number of People Relocated

Although the number of people taking shelter with relatives or friends is generally high in natural disasters, the extremely short notice and evacuation times associated with a toxic spill could result in a greater percentage of the population seeking public shelter in the early phases of an emergency. This situation would be due to a lack of time to contact others to arrange for private shelter. For example, in the case of a chlorine release at

Collins, Mississippi, 40% of those evacuated went to a public evacuation center because they had nowhere else to go.[108] The amount of projected need, then, for public shelter and temporary housing should be estimated somewhat higher than for other types of emergencies. However, as evacuees have time to make other arrangements for housing, the demand for public shelter will decrease.

In the recovery phase, relocation will focus primarily on longer-term temporary housing and care for persons who cannot immediately return to their homes because of safety considerations. In individual cases, it might be impossible to decontaminate a home within reasonable safety or time limits. In such circumstances, permanent relocation would also be required.

The number of people requiring relocation will vary by location and will be affected by the nature of the spill, as well as by meteorological factors such as wind direction (which will influence agent dispersion). For example, at Aberdeen Proving Ground, 545,557 persons lived within the 35-kilometer protective action zone (PAZ) in the west-southwest sector in 1983. However, only 44 persons lived in the east sector of the PAZ.[3] For planning purposes, it is prudent to use high-end estimates, particularly in allocation of resources.

Where a long-term, low-level chemical hazard is involved, the willingness of the population to be moved is an important factor in relocation. That willingness depends heavily upon the interpretation of risk by the affected residents. The community of Centralia, Pennsylvania, was endangered by toxic gases from an underground mine fire. The interpretation of risk by citizens varied widely; the community was divided, with some people wanting to stay and others wanting to relocate. In their study of Centralia, researchers LaPlante and Kroll-Smith[109] found that the following factors can affect the degree to which residents feel threatened:

- *Proximity* — those nearest the source of danger have a greater perception of risk, except for the elderly;
- *Age* — older residents tend to feel less threatened;
- *Media* — the media can shape opinion, particularly in the case of chronic technical disasters where people tend to rely on the media to interpret the situation;
- *Citizen Action Groups* — action groups can also shape opinion;
- *Uncertainty* — uncertainty and vagueness in definitions of contamination danger by experts and public officials may affect perception of threat; and
- *Differing Opinions* — differences over technical solutions required may affect response by the public.

Perception of risk is also affected by the opinions of other community members. Those who want to stay may criticize those who desire to go. Those who do leave may be accused of being selfish, of trying to profit from the government or abandoning their community. In the case of Centralia, close ties to the community were the major reasons given for wanting to stay. However, some refused to leave because they viewed the buyout offers as a conspiracy to acquire residents' rights to mineral deposits under the town. As buyouts were accepted, and parts of the community were boarded up, more of the population opted to relocate.[109]

5.6.3 Planning and Procedural Considerations

Relocation planning should take into account the social and economic needs of the community. The nature of recovery can be dramatically affected by such factors as location and type of housing, availability of services, and distribution of population. Discussion and a planning checklist on evacuee support is provided in the CSEPP planning guidance (Section 8.15 of Reference 16) and in forthcoming planning standards in preparation on this subject.

5.6.3.1 Housing and Sheltering

Three kinds of housing and sheltering operations may be required in the aftermath of disaster — sheltering, temporary housing, and permanent housing. These housing activities may overlap, with sheltering, for example, continuing while temporary or permanent housing is located.[110]

Sheltering (or mass sheltering) consists of providing living quarters, food, and care for large numbers of people. Provision of health services also should be included.[110] Communications and coordination of food, clothing, medical supplies, and personnel are extremely important, but frequently receive insufficient attention. Assurance should be given that shelter managers and volunteers are knowledgeable of procedures and sensitive to the needs of those they serve.

Temporary housing is intended to fill the gap between sheltering and permanent housing, and so allow the establishment of a quasi-normal household routine. Temporary housing frequently consists of a rental unit or a mobile home. Possible locations for temporary housing should be inventoried in advance. In addition to sites for trailers and other emergency housing, locations should be preplanned for shopping and distribution areas and for storage of emergency supplies and equipment. Advance planning for lease or acquisition of such land and for provision of utilities is advisable.[19] If the selected relocation sites do not have adequate and affordable transportation to enable persons to pursue normal activities, then preemergency arrangements should be made for transportation of relocated persons, including special arrangements for persons with disabilities.

Permanent housing may mean a house, an apartment, or a mobile home originally intended as temporary housing. Residential housing may already exist, or major construction projects may be required.

5.6.3.2 Information Services

When people have been evacuated from their homes, it becomes extremely important to provide them with adequate and timely information on their situation. The kinds of questions that may be asked in the aftermath of a chemical accident or incident would probably be similar to those asked by the people of Chernobyl after the Soviet Union's radiation accident. The Soviets' most frequent questions were:[111]

- What are the levels of contamination in the area?
- Is the plant still producing dangerous substances?
- What food is edible?
- When will we go home?

Relocation-related stress can be reduced by planning to provide adequate information services to the relocated population. Arrangements should be made for information centers, newsletters, and meetings. Pamphlets can be written in advance, including information on government and private sources of assistance, as well as answers to anticipated questions. A system involving use of advance-trained relief workers assigned to various groups or areas can be employed to communicate relevant information to evacuees and to listen for concerns and problems.[112]

It is extremely important that boundaries of contamination zones be drawn firmly and quickly, and that they be communicated to evacuees. In contrast, uncertainty or changes in the location of boundaries can create negative reactions among residents and cause confusion and anxiety among property owners.[19]

5.6.3.3 Needs of Children

Increases in responsibilities and workload are important causes of stress for relocated families. The additional tasks may include caring for sick or injured family members, traveling longer distances to and from work, sorting through damaged personal effects, overseeing reconstruction of homes, filing claims for assistance, and so forth. The problems can be compounded for families with children to take care of. Parents faced with the need to be away to handle such postdisaster activities have appreciated the provision of child care services by social service organizations. One such organization, the United Way of Niagara, provided day care service for Love Canal residents.[113]

Planners should also take into consideration the needs of schoolchildren. In the event of a chemical emergency with a prolonged recovery period, where will relocated children go to school? What supplies and books will be needed and where will they be obtained? Will there be a sufficient number of teachers, buses, and drivers?

5.6.4 Possible Resources

A number of possible sources exist for assistance with relocation needs. Traditionally, service organizations such as the Red Cross and the Salvation Army have provided material, money, and volunteer assistance to the displaced. Religious organizations and institutions, professional organizations, Scouts, and other such groups often contribute to such efforts. Businesses and factories may be able to offer services, goods, or volunteer assistance to affected employees and to others. The Friends and Mennonite Disaster Services have provided volunteer construction labor for repairs and replacement housing in numerous disasters. Hotels and schools with dormitories may offer rooms on a short- to medium-term basis. Arranging stays with citizen volunteers in the community or a nearby community is another housing alternative.

While housing with friends and relatives is common in the emergency period, crowding and other problems tend to limit such stays to less than a month. In fact, overall assistance from family tends to decrease rapidly, and greater dependence on institutional and organizational aid is noted in the later stages of a disaster.[19]

FEMA has provided temporary housing in disasters by bringing in mobile homes, which may then be offered for purchase to the occupants (as in the case of the Loma Prieta earthquake). The disadvantages of mobile homes have been noted in the literature, most prominently by Erikson[114] (see also Section 5.7.3 in this report). If trailers are used, the land on which they are placed may need to be rezoned.

The case of Rapid City is illustrative of the problems that can be associated with use of mobile homes (and other temporary housing). There, flooding destroyed the homes of 3,000 families. Locations chosen for the mobile homes provided by the Department of Housing and Urban Development lacked utilities, and the city had to add them. However, later it was found that that expense was not reimbursable from federal disaster funds. Because families were located according to the order in which they arrived, conflicts developed and violence erupted. The fact that there was no public transportation that would enable residents to pursue normal activities added to dissatisfaction. An outreach program was created in response to these problems, and tensions were reduced. Ultimately, the "temporary housing" became permanent housing when families were allowed to purchase the trailers after a year of occupancy.[19]

An alternative to providing temporary housing is the issuing of rent vouchers. The advantages of vouchers are freedom of choice and speed and ease of distribution. However, in the case of major contamination to a small community, or where housing is already in short supply, few (or no) units may be available to rent. Furthermore, potential landlords may be reluctant to accept vouchers, as happened at Love Canal.[113]

The problems of residents who originally occupied rental units should not be overlooked in the relocation process. Although they may seem to have greater freedom to relocate than homeowners, renters (particularly those with low incomes) may have difficulty in locating equivalent housing at rates they can afford.[113]

Availability of public transportation should be considered when locations are selected for temporary housing. It is especially important that transportation be available to and from assistance centers and health facilities. If public transportation does not exist, it will be necessary to make other arrangements to transport evacuees to transact essential business. Some alternatives include the use of school buses or prearranged contracts for the leasing of buses or vans from commercial firms. Volunteer organizations, religious groups, and others may be able to help with transportation.

5.6.5 Key Questions

The following key questions regarding the material in this subsection should be considered in the course of developing reentry, restoration, and recovery plans for a CAI:

- Who will coordinate relocation?
- How should the community be restructured if reoccupation of the area is impossible or significantly delayed?
- Will land use changes be needed or desired?
- To what extent will business and the public be involved in decision making?
- What measures should be taken to control fraud and price gouging by contractors and suppliers?
- What plans should be made to meet the needs of schoolchildren?
- Will day care be available to help parents burdened with additional responsibilities caused by the emergency?
- How will existing plans and programs for roads and construction be affected?
- What mitigation measures (related to this or other hazards) should be taken into consideration in land use planning?

- What type of shelter or temporary housing should be used?
  - trailers?
  - existing private housing?
  - prefab buildings?
  - schools or public facilities?
- Where will housing and other facilities be located?
- Will rent vouchers be provided?
- Should rent or price controls be imposed?
- How will landlords be encouraged to accept rent vouchers?
- How will landlords be encouraged to lease properties for short periods of time?
- At what point will shelters be closed?
- What transportation will be available for those who have none, who lost their vehicles, or are unable to drive?
  - school buses?
  - public transportation systems?
  - contracts with private companies?
  - volunteers?
- What provisions should be made to provide specially equipped vehicles and other facilities for persons with disabilities or special medical needs?

5.7 MEDICAL, PSYCHOLOGICAL, AND SOCIAL CONSIDERATIONS

5.7.1 General

Research indicates that physical and stress-induced illness is more common in cases of extended technological hazard (such as Love Canal) than it is following natural disasters.[115] It is important to include both medical and psychological considerations in overall planning for recovery. In addition, there will be numerous impacts on medical facilities of the community as a result of the emergency and recovery activities. To ensure that everyday functions continue normally, it will be necessary to carefully plan for recovery phase medical needs.

5.7.2 Medical Impacts

In most disasters, the emergency phase of medical care lasts five to eight days after the event (Lechat 1979, in Reference 112). In addition to the need for continued care of those injured in the original release, it may be necessary to treat injuries suffered by recovery workers in contaminated areas or by other persons illegally or unknowingly entering such areas. The special needs of those with physical impairments must also be recognized.

Medical impacts of a chemical spill, in the recovery phase, would include increased demand on hospital beds, supplies, and staff. Shortages may be aggravated by loss of facilities in the disaster or casualties among medical professionals. Outside assistance may be required for a long period.

Should an agent release be secondary to a precipitating disaster, the medical impacts and needs may be significantly altered. A fire, for example, could strain resources of burn units and create an increased need for certain kinds of medical supplies.[112]

Monitoring and testing activities will count for the majority of medical activities in the recovery phase. Accompanying the collection of data, however, is the responsibility for synthesis, analysis, and communication of progress and results to the patients. It is important that medical information be given out in a form and language understandable to the patients. Failure to do so can create fear, confusion, and antagonism among the citizenry, who will then attempt to find answers elsewhere, as at Love Canal.[113]

The assignment of physicians and other professionals for work following the emergency response stage of the accident should be carefully planned and monitored. Those sent in from outside the community should be assigned for sufficient periods of time to become knowledgeable of the details and progress of the health problems they encounter.[113]

5.7.3 Psychological Impacts

5.7.3.1 Introduction

Some debate currently exists about the extent of psychological impacts that can be expected in disasters. However, consideration of psychological impacts by public officials in planning and decision making may reasonably be expected to improve the quality of recovery on the individual and community levels by reducing stress, illness, and conflict, not only for victims, but for helpers as well. Consultation with mental health professionals on decisions involving public participation is recommended. Professionals might suggest, for example, that authorities avoid separation of children from parents, or might recommend steps to lessen negative impacts of disaster aftermath on survivors.[112]

In the case of toxic chemical disaster, stress can result from "fear of the environment, the loss of work, and the dread of longer-term consequences."[112] Those at risk for stress include not only those directly involved in the disaster, but also others affected by the impact of the disaster on the community, those with family or friends involved in the disaster, and those who work in the disaster area or with victims.[112] It has been reported that effects of technical disasters are more severe than for natural disaster and last longer — sometimes years.[116]

5.7.3.2 Planning for General Care

Emergency planners and workers should be aware that relocation can be very stressful for those who must leave their homes. Possible effects include:[112]

- Loss of independence and dignity;
- Unfamiliar or uncomfortable surroundings;
- Life changes — work, school, personal;
- Loss of social contacts;
- Uncertainty;
- Bureaucratic difficulties;
- Continuing stress from the disaster itself; and
- Family tensions.

Awareness of such sources of stress may be helpful in the planning and implementation phases of recovery. The importance of actively involving victim representatives in the recovery process should be emphasized. Distrust and anger can result when outsiders appear to dominate recovery administration. Ignoring or failing to recognize the goals and needs of the community can hurt recovery and can create or strengthen feelings of apathy and helplessness.[112] Consideration of such factors in the planning process may prevent or reduce much of the stress associated with relocation for individuals, with benefits for overall community recovery as well.

5.7.3.3 Disaster Workers

It has recently been discovered that disaster workers are subject to a syndrome called posttraumatic stress disorder, which has long been recognized in combat troops.[117] Symptoms of depression, impaired memory, and sleep disturbance can affect persons exposed to horrifying events. Of particular importance to recovery planners is a recent study indicating that approximately 40% of disaster workers experience symptoms three weeks after the disaster, and 20% have symptoms persisting for up to one year. Attrition rates among emergency service personnel after a disaster have been estimated at 1-50%, depending on circumstances of the event.[117]

Workers subjected to extreme stress during the emergency phase may suffer from "decreased ability to think clearly . . . and reduced ability to master tasks" (Sedgewick, in Reference 117). This condition could create significant risk for life-threatening errors should personnel thus affected continue to perform their duties in the recovery period, as is likely. The solution is to mitigate the effects of stress through preplanning to reduce exposure to stress and through counseling services that seek to treat existing symptoms. It should not be forgotten that the stress felt by disaster workers may, in turn, affect the quality of assistance that they are able to extend to disaster survivors. Some basic ways in which workers are helped to deal with the stresses involved are:[112]

- Support of family and close friends to offer consolation, security, healing;
- Close bonds with other workers; and
- Help from professionals or team leaders through debriefing and talking over the experience and their feelings.

It is especially important to plan ahead for debriefing programs, because it takes several months to recruit and train the teams. The start-up cost of a debriefing team is approximately half the cost of training one paramedic.[117]

A good preventive measure for stress among workers is to restrict the number of hours worked. To implement such restrictions, however, requires advance planning with regard to the number of personnel available and the establishment of shifts. Fifteen-minute breaks are recommended for each hour of intense activity, and after 12 hours, disaster workers should be required to physically leave the disaster scene for 6-8 hours of rest.[117]

Changing the type of activity is another stress-reduction technique. Physical exercise periods can help, too, by allowing the body to release the harmful chemicals produced by stress. The condition of the worker, however, must be considered in designing such a program.[117] Important elements of stress reduction for disaster workers include food, shelter, privacy, rest, psychological support, religious support, and medical support.

Individual and community recovery are mutually supportive. Not only is community recovery aided by the psychological recovery of individuals, but emotional recovery is dependent upon economic and housing recovery (Bolin, in Reference 115). Raphael[112] suggests the following considerations in planning for recovery:

- Recognize the different kinds of victims involved,
- Integrate psychosocial care with other aid,
- Provide specialized care for persons who have difficulties coping, and
- Plan and monitor the transition of care.

A model of psychosocial care should include:

- Psychological triage and first aid,
- Psychosocial support and assessment alongside other aid and care,
- Preventive assessment and management of at-risk groups,
- Debriefing for workers and others,
- Treatment of specific disorders by mental health professionals, and
- Longer-term mental health care.

Program effectiveness is increased when planning is done in advance of an accident or disaster. For example, in an Australian disaster, an expert was hired to assist workers, officials, and the public with planning. Workers were provided with handouts and educated on emotional first aid. Debriefings and stress management assistance were available, and media presentations were used to create public awareness of disaster stress reactions.[112]

Educational materials could be prepared in advance to explain common postdisaster reactions, grief processes, needs, ways to help, and other information. These materials could be helpful to schools, social welfare professionals, doctors (medical journals), and the public (through publication in popular magazines). Leaflets might be distributed to victims. Teachers might be taught how to use techniques that can help schoolchildren express and handle their feelings. Presentations should be planned for radio, television, and newspapers.[112]

Consideration may be given to setting up a task force to create a mental health program by assessing needs, setting goals, defining procedures for implementation, monitoring, funding and evaluation.[112] The National Institutes of Mental Health has previously provided grants for programs through its Disaster Assistance and Emergency Mental Health Section.

One final note (and suggestion) can be made regarding psychological implications. Raphael[112] writes that "inherent in the concept of victim is passivity, the sense that something is done *to* the person, something over which he has no control; so feelings of helplessness may also be evoked by the label and the experience." For this reason, it may be beneficial for recovery workers and public affairs personnel to avoid use of the term "victim" wherever practical, since it is important to the ultimate recovery of survivors to retain some sense of control over their lives and those of their loved ones. A possible alternative is use of the term "survivor" which has more positive connotations of self-sufficiency and strength.

5.7.4 Social Impacts of Protective Measures and Sociological Effects

Important differences have been reported in the social impact of a toxic disaster and that of a natural disaster. One such difference is the perception of toxic disaster as a "loss of control" versus the perception of natural disaster as a "lack of control." Because of this difference, survivors of man-caused disaster may be distrustful and angry.[118] In addition, a sudden and rapidly progressing disaster, similar to that predicted for an accident involving chemical agent, does not allow the social system as much time to adjust to the situation as with a hurricane, for example.[117]

Unlike many other disasters, toxic disasters leave the population heavily dependent upon experts to make decisions and to manage various aspects of their lives; as a result, they may become "disabled" (Illich 1977, in Reference 118). Provision, therefore, should be made to provide the affected population as much direct participation as possible in decision making, with the goal of enhancing the individual’s ability to recover.

It is important to note that negative feelings will be particularly in evidence during the recovery period. In contrast to the emergency period, the recovery period is one of decreased informal assistance and increased numbers of bureaucratic structures. Uncertainty and frustration, combined with full realization of the extent of loss, contribute to general feelings of hostility among survivors.[119]

Raphael[112] points out that the psychological effects on survivors — anxiety, grief, fear, and exhaustion — may affect interactions with family and friends, and their ability to work. As a result, survivors may exhibit greater impatience with inefficiency and failure of services and organizations.

After the Buffalo Creek flood disaster, the way Department of Housing and Urban Development mobile home camps were set up for 2,500 evacuees had a significant impact on recovery. Mobile homes were set up without regard to previous neighborhood patterns (spaces assigned on a first-come first-served basis) so that families were placed among strangers. Conflicts erupted. Also, there was little privacy, and the trailers were too small for large families. Some complained it was impossible for all of the family to sit down to a meal together. No play areas were provided for the children.[114] The result, in general, was a loss of "sense of community" and a lowering of morale.[112]

Information on the possible effects specific to this program is provided in Reference 120. Planning in these areas following a hazardous chemical spill is discussed in the *Handbook of Chemical Hazard Analysis Procedures*.[72]

5.7.5 Key Questions

The following key questions regarding the material in this subsection should be considered in the course of developing reentry, restoration, and recovery plans for a CAI:

- How will medical information be transmitted:
  - to the public?
  - to individuals?
  - to health professionals?
- What measures will be taken to protect the privacy of individuals in compiling and releasing information?
- How will continuity of medical care be assured?
- What information and tests will be needed to provide long-term care?
  - who will coordinate to avoid duplication?
  - who will provide testing?
- What role will government health professionals play?
- How long should health be monitored and tests conducted?
- What impact will private medical insurance have upon care and costs?
- Who will provide care for persons with low income; for the disabled?
- How will postdisaster counseling be provided for survivors and emergency workers?
  - who will provide the service?
  - for how long?
  - using what resources and methods?
- What preventive measures will be taken to avoid or decrease stress on emergency workers?
  - scheduling of relief personnel?
  - required rest periods?
  - regular debriefings?

5.8 PUBLIC AWARENESS AND INFORMATION

5.8.1 General

The recovery and restoration phase of a chemical accident will require an active public information function. This function is both required by law and sensible to ensure the success of the recovery. The key law is the Superfund Amendments and Reauthorization Act (SARA), which requires certain public information and coordination actions, such as public meetings and publication of plans. Good communication with affected populations, especially those who were evacuated, must be established and maintained as a function of the recovery. Communication with the news media should be honest and open to help restore public confidence in the Army and civilian response organizations following an accident.

In the CSDP and in particular in the CSEPP, procedures and structure have been established to address public information office functions in the recovery phase. This structure is based in part upon the joint FEMA and Department of the Army memorandum of understanding that calls for joint actions in the area of community relations.

Specific requirements for public information functions in the emergency preparedness program are outlined for both the Army and the civilian emergency management agencies. The planning guidance documents are DA Pamphlet 50-6[17] for Army personnel and the *Planning Standards for Public Education and Information for the Chemical Stockpile Emergency Preparedness Program*[121] (Appendix J of the CSEPP Planning Guidance Document) for the participating civilian agencies.

5.8.2 Transition from the Response Phase

When the recovery phase begins, there is a distinct shift from response to recovery activities. Because the command and control for the emergency response portion of the accident will change from that specified in the emergency response plans to that designated in the remedial action plan, the public information office function may have to respond to different decision makers and a different system for coordinating information to be released.

Through the joint structure of this program, both Army and civilian public information offices are expected to work in coordination. The joint public information function that will be employed during the recovery phase is influenced by the public information function that will operate in the response phase. This influence results from the previous distribution of news and information, the continual operation of a joint information center, effectiveness of the designated spokespersons, and whether any mistakes in communications, either factual or stylistic, were made. Recovery-phase public information office functions could also depend upon preemergency information, which was previously distributed, and established contacts with media and community leaders. Transition will depend upon the success of the response phase and to a certain extent the thoroughness of the preemergency information.

5.8.3 Joint Information Center — Recovery Phase

The emergency phase and recovery phase planning guidance for CSEPP will provide for a functioning joint information center, where representatives from both the Army and civilian agencies will conduct such activities as holding media briefings and distributing news releases, fact sheets, and other materials. This joint information center should continue to function as the emergency phase turns into the recovery phase, and it would be expected that the events will impact the type of operations conducted. There will be pressures on the recovery-phase decision makers to take actions, and some of that pressure will be from the news media representatives at the joint information center. Recovery-phase public information office functions will be similar in intensity to those of the response phase, but they also will be cumulative. For example, news releases might be issued on civilian or military casualties.

Rumor-control activities could continue in the recovery phase. Rumor control should consist of a formal monitoring system for the accuracy of information and the degree of interest from the affected communities. The press releases issued in the recovery phase will reflect not only new information, but also will address and correct issues or questions that may arise from the rumor-control function.

Briefings could be presented at the joint information center and at mass care centers. People at mass care centers will need critical information and answers to their questions. The scope of the accident and the resulting attention from the media may grow to a national, and perhaps an international, level. This increased exposure may change the type and level of briefings required.

An important aspect of emergency public information during the recovery phase is the recovery plan. Development of this plan will probably involve activities at the joint information center because public participation is required by law. This plan and the law are discussed in the following sections.

5.8.4 Recovery Plan

Section 117 of SARA, which specifies public participation, outlines the approach to take after a chemical accident occurs and defines when the response organization starts to develop a recovery plan. Briefly, this section requires the following:

- Publish a notice and brief analysis of the proposed plan,
- Make the plan available to the public, and
- Provide the opportunity for written and oral comments and the opportunity for a public meeting near the facility.

In addition to Section 117 of SARA, the Department of the Army, in DA Pamphlet 50-6 [Section 14-5.c(6)], has defined an implementation process to allow the public to participate in technical response and recovery decisions in their communities.[17] For example, the Army recommends that interviews be conducted with community leaders and public interest groups to receive input into the plan.

When the recovery phase begins and discussions start with the public, continuing an open and honest style of communicating is important and recommended. The DA Pamphlet 50-6 specifies an honest and accurate communication style with the public and also states that this information flow needs to occur in a timely fashion. The DA pamphlet emphasizes that information needs to flow two ways, as intended in Section 117 of SARA.

5.8.5 Administrative Record

Section 113 of SARA discusses the formation of the administrative record. According to the law, the President or his delegate develops this record, which will form the basis of the selection of the response action to be taken. The record is to be made available for public review so that affected people can participate in the planning of remedial actions. This record is also intended as documentation in case of intervention and for judicial review of the response or remedial actions.

Creating and maintaining the administrative record is a function involving public information officers, because a major purpose of the record is interaction with the public. Specifically, notification to affected parties must be given, along with analysis of the plan for action; a period for comments on the plan and for inclusion in the administrative record must be provided; and last, a public meeting on the plan of action must be held. Section 113 of SARA also refers to Section 117 of SARA, which requires publication of the plan in the local newspaper or equivalent. This publication then will become part of the administrative record.

5.8.6 Media Relations

As described above, the joint information center will be in operation and activities will occur in the response phase or even earlier (before the event) that will affect media relations. The CSEPP information and education standards[121] state that procedures to provide current information to the news media are important and make recommendations regarding those procedures. This nonemergency education of the media becomes important during an emergency, both in the response and recovery phases.

The planning guidance also emphasizes the need for coordination among the key organizations when disseminating information to the media. As described by Edelstein,[118] honesty and openness also are important attributes in media communications.

5.8.7 Key Questions

When the Joint Steering Committee accepted the CSEPP public information and education final standards, many of the questions regarding the operation and procedures for a joint information center and dissemination of information were answered, as long as the state, local communities, and the affected installation implement the standards appropriately. A comprehensive emergency public information plan that is coordinated among the parties should assist in the success of the recovery. Signed and promulgated memoranda of understanding should also assist in providing timely, accurate, and responsive information during the recovery phase of an accident. The following key questions should be considered in developing these plans and memoranda:

- How will effective coordination occur with (and within) the joint information center?
  - who should release what information?
  - when and with whose approvals should this information be released?
  - through what media should these reports be made?
  - how long should these operations continue during a recovery phase?
- How will dissemination of public information comply with the law?
  - with the recovery plan?
  - with the administrative record?

5.9 INFORMATION PROCESSING, DOCUMENTATION, AND DATA MANAGEMENT

5.9.1 General

Information needs during the recovery phase will be different from those during the response phase; however, the recovery-phase needs are no less important. The Emergency Management Information System (EMIS) is currently being defined and implemented. Exact equipment and capabilities will depend in part on what off-post organizations choose to purchase.

The EMIS will support response and recovery planning and operations by providing for communication of information between federal, state, and local organizations. The proposed system will include database information, provide interface with analytical planning tools and models, and provide planning support.[49] Hardware and software recommendations and design criteria are further described in the following program documents:

- *Automated Information Management System Development Plan*, and
- *Functional Specifications for an Automated Emergency Management Information System to be Used On- and Off-Site at Chemical Stockpile Sites* (draft).

Several databases are being developed to assist with reentry and recovery planning and activities. It would be advisable, however, for each community or organization to have access to such information at more than one location in the event the primary location is affected in an emergency. Another general consideration is that of confidentiality of information, particularly regarding personal health and medical information.

It is critical that those who are expected to use the information system be fully trained in its operation. Toward that end, a number of workshops are planned to assess current capabilities and needs and to provide technical information to state and local participants.

5.9.2 Potential Databases

Database information that would be of benefit to emergency planners and administrative organizations is discussed in the following subsections.

5.9.2.1 Technical Assistance Data

A list of the names and short resumes of technical experts who can be called upon for planning assistance or who have contributed technical assistance to the CSEPP (with areas of contribution indicated) would benefit planners. A similar, but more comprehensive, list would be valuable to administrators in the aftermath of a chemical accident or incident and would provide sources of additional information and advice on recovery activities. The expanded list should include private and government experts, university researchers, commercial contractors, and suppliers. On-call expertise should cover the full range of recovery activities and needs. Relevant topics include toxicology, computer technology, sampling equipment, sociology, soil science, agronomy, construction equipment, and remediation technology, to name a few.

5.9.2.2 Relocation and Reconstruction Planning Data

A database for relocation and reconstruction planning should include lists of possible relocation sites, with detailed information on facilities available, associated costs of acquiring or leasing, number of residential units that can be accommodated, and other such data. Other information to include in a database for relocation planning includes cadastral surveys (showing property boundaries, buildings, etc.) and current land use and zoning information. A database showing projected or planned land use would be extremely helpful in reducing the time necessary to make decisions related to reconstruction. A list of resources available should be prepared in advance so that any deficiencies can be noted and addressed. Resources may include sources of portable housing, food, clothing, and equipment; volunteer personnel; vehicles; medical supplies; and other goods and services. Evacuee registration information has been recommended for inclusion in a database.[49] This information would be helpful for planners and administrators and could be used in reuniting family members.

5.9.2.3 Decision-Making Data

Checklists and procedural aids for recovery and reentry activities should be created in advance for the benefit of decision makers. Additional information on decision-making aids is presented elsewhere in this report.

5.9.2.4 Environmental Data

An environment database will be needed to compile monitoring data collected on the levels of contamination in air, water, and soil. Atmospheric, hydrologic, and topographic information will assist scientists in projecting any possible redeposition of agent by wind and precipitation in the postemergency period. A baseline environmental information database containing site characterization data (as described in Section 5.5) will permit comparison of postaccident contaminant levels with preexisting background levels and thus provide a basis for planning remedial actions and tracking their success.

Maps will be needed to depict contamination boundaries and areas and to plot locations of crops, pastures, casualties (human and animal), and sampling and monitoring stations.

5.9.2.5 Health and Medical Data

An extensive amount of medical data will be collected, and this information will be important to medical personnel, physicians, and others who must plan for short- and long-term health needs of the affected population. Security of such information will be important. Planners should resolve in advance such issues as (1) to whom information should be made available, (2) how and with what documentation and legal clearances such information should be made available, and (3) in what form the information should be made available.

To maximize effective use of the databases, potential users will need to work with information systems planners to ensure that format and content of the databases are compatible with the output desired. For completeness of information and for ease and speed of input, forms created for use by field medical and monitoring personnel should be compatible with the design and format of the database.

An information system could be used to track medical samples between source and laboratories and thus help reduce the chances of an important sample's being misplaced or lost. Tracking of medicine, supplies, and equipment could assist in distributing these items according to need. Creation of a human exposure register has been recommended[4] as a means of monitoring agent exposure of emergency workers and evacuees.

5.9.2.6 Damage Assessment Data

Considerable damage assessment data will be included in the environmental and medical databases developed in the early phases of the operations. Additional information will be added as the recovery, reentry, and restoration efforts progress. The types of additional data added will include information collected by field teams on damage to structures, utilities, and personal property; costs of restoration; tax information; and agricultural losses. Also, a register of confiscated property would be important for confirming ownership and for damage assessment.[4]

5.9.2.7 Other Data

Other possible uses of information systems include tracking of needs and progress related to assignment of housing, notification of next-of-kin, disposal of contaminated items, distribution of recovery supplies and equipment, assignment of personnel, traffic routing, and economic data and analysis.

5.9.3 Key Questions

The following key questions regarding the material in this subsection should be considered in the course of developing reentry, restoration, and recovery plans for a CAI:

- What types of data are important to restoration activities?
- From what locations can these data be accessed?
- What confidentiality provisions should be made?

5.10 ECONOMIC IMPACTS

Experience gained in previous accidents, such as the Union Carbide leak in Bhopal, India, and the Chernobyl nuclear accident in the Soviet Union, as well as the results of modeling efforts, indicate that a CAI could cause substantial damage to the local economy.[122-128] The economic impacts would include the primary (direct) effects on the population, private entities, and public infrastructure, as well as the secondary (induced) effects resulting from iterations of the primary losses throughout the economy.

The primary economic losses would involve the late-stage protective measures: resettlement and relocation costs, losses from restrictions on access, property buyout costs, decontamination costs, and the costs of diverting regional products out of the ingestion pathway. In addition to the employment lost at the accident site, evacuations could lead to closure of commercial establishments, professional services, business and government offices, hospitals, schools, and colleges. Such closures and the consequential labor scarcity could bring a halt to essential civil supplies and services.

Beyond this general expectation of the potential for major economic loss, however, it should be kept in mind that the actual extent of the impacts from a specific accident would depend on the magnitude of the release, the area in which it occurred, the time or season of the occurrence, and the relative economic activity in the area at the time of the accident.

The most appropriate approach to assessing loss would seem to be use of available models and methods as guides to estimate economic impact when such an accident actually occurs and specific conditions are known. A thorough review of previous studies regarding postdisaster economic recovery after other types of emergencies is provided in Reference 129. What is common in all of the studies conducted on disasters is that a negligible effect was found on the long-run economic performance.

5.10.1 Late-Stage Protective Measures

The late-stage protective measures have the potential to severely curtail major sectors of economic activity. The reduction in business activity would affect the population through lower employment and earnings, and the limitation of the supply of certain necessary inputs/products could have what is called a "supply-driven" impact on the economy. Davis and Salkin[130] used an input-output modeling technique to determine the impacts on a region resulting from the shortage of certain key inputs due to strikes and natural disasters. This work could be applicable in evaluating regional economic impacts resulting from late-phase protective measures in the event of a CAI.

The interaction of the demand and supply systems in the pre- and postemergency economy can be illustrated by a schematic (Figure 3) modified from Wetzler.[131] A simplified illustration of the normal operations of the economy is shown inside the dotted line, with perturbations to the economy outside the dotted line. The preemergency economic projections are modified by the damage model. Postemergency factors that could affect economic activity are briefly discussed below.

Resettlement and Relocation: The extent and types of costs involved in resettlement and relocation actions can vary widely. For example, if the relocation is conducted by local emergency response teams, no incremental out-of-pocket expenses are realized beyond what has been already budgeted. If external forces, such as the National Guard, are required or if substantial volunteerism is relied upon, the incremental cost can be calculated in a straightforward manner. Case studies are one way to analyze the potential situations that

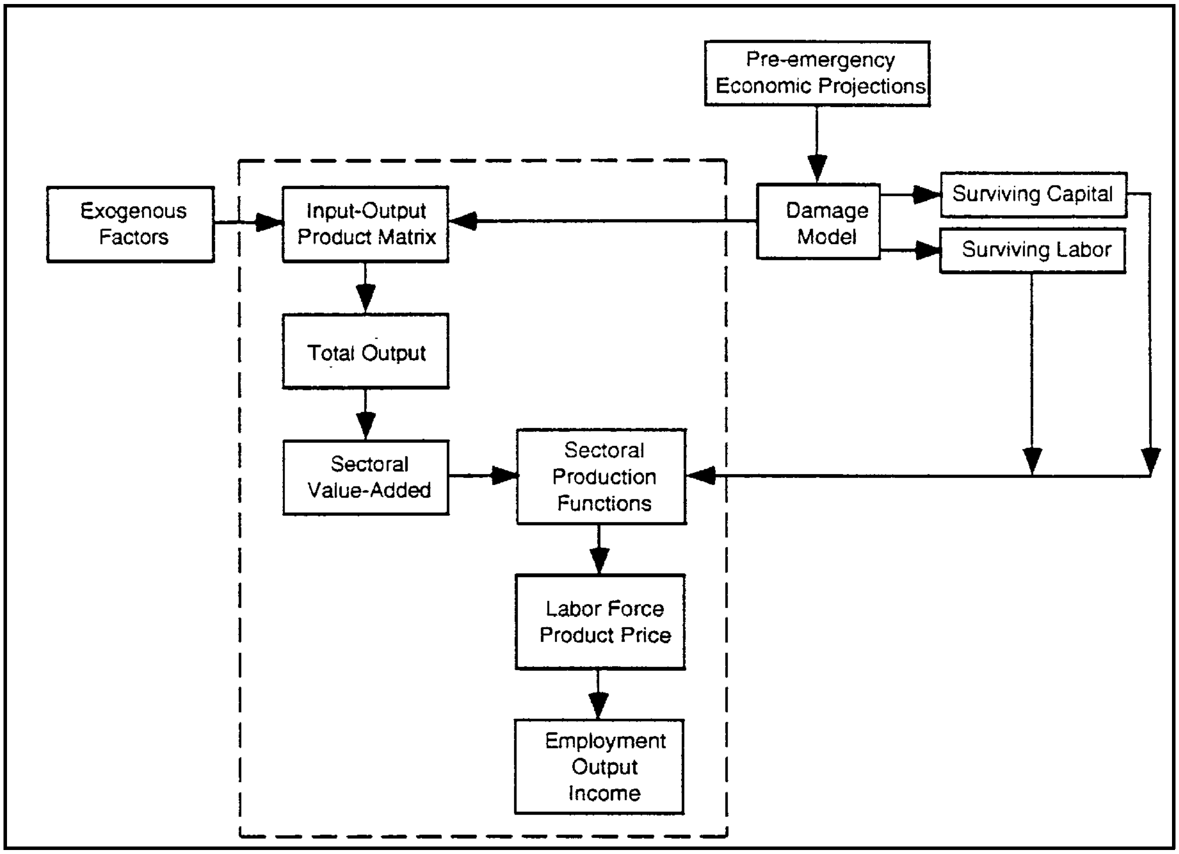

FIGURE 3 Postdisaster Economic Model (Source: Modified from Reference 131)

may face emergency response teams and the consequent costs and impacts occurring from resettlement and relocation actions. Several such case studies are discussed in References 19, 132, and 133. However those accounts do not specifically include methods for estimating costs incurred.

Restrictions on Access: Restricting access to the affected area is another action that can reduce the inputs to a region. In this case, the critical inputs that are being curtailed are workers and transportation systems. Without these inputs, all economic activity breaks down.

Buyout Costs: If the late-phase measures require permanent relocation, fair market value can be used for assessing the property itself. State-of-the-art real estate valuation techniques using before-accident market conditions are directly applicable to this type of analysis. However, some things that will be lost in this scenario are difficult, if not impossible, to valuate and to compensate, such as the sentimental value of the residences given up and the "intrinsic value" of living at a particular location.

Decontamination Costs: Much of what has been written in the literature involves the primary cost of decontamination.[134,135] However, the costs of decontamination also should account for the opportunity cost resulting from interruption of the economy during the process and for other secondary economic effects.

Diversion of Agricultural Products and Ingestion Pathway Costs: The impacts of a CAI on agricultural production could reach far beyond the region of directly affected population. Once the region of influence has been determined, it is possible to estimate the extent to which agricultural production will be affected. The methods employed will depend on the production units in question, the types of production affected, and the market conditions evident during the diversion. The general method to be employed requires the identification of the interaction between sectors and inputs, much like the model created by Sobin[136] for post-military-attack economic recovery.

5.10.2 Secondary Costs

When the primary costs are calculated, the secondary costs in the region affected by the accident can be estimated with both demand- and supply-driven input-output modeling techniques. To make this estimate requires development of a model of the flow of inputs, the production of intermediate and end-use products, and the distribution and sale of these products in the region of influence. Miller and Blair[137] present information on the use of input-output models and provide a comprehensive list of applications.

The total loss is calculated by use of input-output multipliers and is based on loss of final demand (in dollars) per dollar loss of production. A system for estimating regional input-output multipliers, known as the Regional Input-Output Modeling System (RIMS), has been developed by the Bureau of Economic Analysis of the U.S. Department of Commerce. The three categories that are measured by the system are output, earnings, and employment. RIMS multipliers are available for every county in the United States and can be kept current for quick reference during emergency recovery situations.

5.10.3 Costs of Agent-Induced Health Effects

Economic evaluation of agent-induced health effects requires that subjective judgments be made regarding the value of human life on both a qualitative and quantitative basis. The primary method used to value human life is to determine the total cost to society that is likely to result from the effects of exposure. These economic costs are divided into "direct" and "indirect" costs. Direct costs include treatment, travel to obtain treatment, patient care, and equipment and supplies. Indirect costs include losses due to reduced productivity of the affected individuals or their families. Direct costs are measured in terms of monetary outlays for health care and services. Indirect costs do not involve monetary outlays, but instead are measured in terms of value of lost productivity. Because the method used to calculate lost productivity is similar to that used to value current capital investments, this method is known as the "human capital" approach.

5.10.4 Compensation for Financial Loss

All of the models of economic impacts address economic losses in some aggregate form. Compensation must ultimately occur at the individual entity level, however. Each citizen and private business can apply for damages, but the problem at hand is how to equitably and efficiently distribute the whole to the individual parts. The key question to be addressed by policy makers is as follows: Is compensation distributed to retain (or maintain) the distribution of wealth prior to the accident, or is the compensation scheme to be designed to equitably distribute the funds without prior knowledge of wealth position?

5.10.5 Key Questions

The following key questions regarding the material in this subsection should be considered in the course of developing reentry, restoration, and recovery plans for a chemical weapons agent accident:

- Who will perform damage assessment?

  - using what procedures?
  - with what kind of documentation?
  - coordinating with which agencies?

- How will insurance coverage of evacuated home and business owners be affected by long-term nonoccupancy?

6 CONCLUSIONS

Planning for reentry, recovery, and restoration following a chemical weapons accident at storage depots in the continental United States is an essential element of the larger emergency response. Not only can the environmental persistence of certain chemical agents released during an accident mandate extensive recovery and restoration activities, but the existence of a recovery plan can be expected to reduce adverse social impacts. In identifying major reentry needs and discussing how planning may address them, the authors of this report attempt to show how this emergency response component can be accomplished, stopping short of presenting planning guidance or actual plan material.

Following the transition from the emergency response phase of a chemical weapons accident to the recovery phase, the attention of emergency responders will shift to the environmental cleanup process. They will find that a number of federal and state statutes, notably CERCLA, RCRA, NEPA, and individual state statutes, will regulate this endeavor. In addition, those who have experienced losses will be able to seek compensation through the Army claims process.

While it is clear that the Department of Defense will play a major role, the legal framework for environmental cleanups contains potentially conflicting standards and procedures. The requirements of RCRA may differ from those of CERCLA. State law may purport to place a state agency in control of remedial actions, while federal law designates one or more federal agencies. Even within CERCLA, the natural resource damages provisions create the possibility for confusion over who is to be in charge. Thus, one element of a smooth recovery will be development of a memorandum of understanding, supported by a baseline survey of resources in the vicinity, that integrates as many of these different laws as possible into a cooperative structure for conducting this activity.

Recovery, reentry, and restoration planning will require that a number of elements be addressed. On a technical level, a sampling and monitoring program for potentially contaminated areas will have to address a myriad of collection, transport, analysis, and equipment issues. Personnel who must work in potentially contaminated areas must be protected with appropriate equipment, clothing, monitoring, and medications; regulatory guidelines for allowable civilian emergency worker exposure levels remain to be determined, and the application of OSHA emergency worker protection standards to these accidents must be clarified. Access control may be a long-term protective action for the public, and the use of this measure will create the need to decide both reentry intervals and reentry levels based on suitable field test methods. Methods must be developed to detect and control chemical agent in crops, livestock, water, and other potential ingestion routes. Finally, a complex decontamination effort may be required that relies on contamination-measuring methods that have not yet been fully developed and that is preceded by a sophisticated planning process to determine the proper decontamination methods to apply to various contaminated areas and objects.

Damage to the social fabric also may require repair. Relocation into temporary housing could be particularly difficult, and an effort to identify in advance suitable locations for such housing could make the efforts of service organizations like the American Red Cross considerably easier and more effective. Medical and psychological problems present special planning problems, both in ensuring the availability of a sufficient number of physicians who are familiar with the community and in planning for sufficient resources to treat psychological stress in emergency workers, as well as in the survivors themselves. One important method of alleviating public concerns is to operate an open and honest public affairs program. Finally, economic impacts, while difficult to estimate, must be taken into account. Such losses include both primary impacts (such as property losses) and secondary impacts (such as reduced business activity). Losses due to injury also must not be overlooked.

If a commitment to recovery and restoration planning is to be made, several initiatives must be undertaken. A number of unsettled regulatory criteria must be developed or clarified, including development of reentry intervals and levels, exposure guidelines, criteria for off-post personnel protective equipment, the level of required decontamination of contaminated materials, and the process for carrying out a natural resource damage assessment. Measurement methods must be developed and surveys carried out to define environmental and natural resource baselines. Action levels for different agents in various media must be established by interagency agreements as needed. A generic recovery and restoration plan that integrates the elements discussed in this report into an actual model plan should be developed.

The challenge of planning for a chemical weapons accident is a daunting one. The lethality of the agents, the diversity of the surrounding communities, and the present undeveloped state of recovery planning worldwide all are significant obstacles to enhancing public protection. But the national and international importance of improving the safety of stored chemical weapons is great, and the recovery and restoration aspects of this endeavor must reach full development.

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APPENDIX A:

GLOSSARY OF TECHNICAL TERMS

Access Control: The prevention of unauthorized entry into a specific area. Road barriers and traffic control are used to assist access control. The access-controlled area may be established to control and monitor a restricted area that may have undergone agent contamination.

Decontamination: The reduction or removal of contaminating agent from an area, a structure, an object, or a person.

Emergency Phase: As used by FEMA and EPA, the initial phase of response actions, during which actions are taken in response to a threat of release or a release in progress. Short-term protective actions such as sheltering and evacuation may be taken during this phase in order to mitigate the hazard from immediate exposure to the passing plume.

Lewisite: Dichloro(2-chlorovinyl)arsine, a blister agent.

M55: An aerial rocket weapon that contains a chemical agent.

Mustard: H/HD, bis(2-chloroethyl) sulfide, a blister agent; HT, mustard-T mixture, a blister agent.

National Defense Area: An area established on nonfederal lands located within the United States, its possessions, or its territories, for the purposes of safeguarding classified defense information or protecting Department of Defense equipment and/or material.

Reconstruction: Rebuilding and replacement of destroyed structures and utilities to approximate predisaster condition.

Recovery: The period following response when immediate threat to human life has passed and general evacuation has ceased. Recovery refers to the actions taken to restore an affected area as nearly as possible to its preemergency condition. Thus it refers to the process of reducing exposure rates and concentrations in the environment to acceptable levels for unconditional occupancy or use after the emergency phase of an accident or incident. Recovery includes both short-term and long-term activities. Short-term recovery returns vital systems to minimum operating standards, and short-term operations seek to restore critical services to the community and provide for the basic needs of the public. Long-term recovery focuses on restoring the community to its normal, or improved, state of affairs, and long-term recovery activities are intended to return life to normal or improved levels. The recovery period is also an opportune time to institute mitigation measures, particularly those related to the recent emergency. (From a surety perspective, the term "recovery" has, in some circumstances, been defined in a different sense as those actions required to resecure the munition involved in a chemical agent accident or incident, but that definition is not in use in this report.)

Reentry: The temporary, short-term readmission of persons to a restricted zone to perform some essential task (for example, emergency workers performing search and rescue operations, or a farmer returning to an area to feed livestock) (controlled reentry). This term is also used in the context of uncontrolled, permanent reaccess to refer to those provisions leading up to the reoccupation or use of previously restricted zones after the hazard has been reduced to acceptable levels (uncontrolled reentry).

Release: Controlled or uncontrolled escape of chemical agent into the environment.

Relocation: Temporary or permanent removal of a population or community in response to an emergency or disaster; a protective action in which persons are asked to vacate a contaminated area to avoid chronic exposure from deposited contamination. Relocation is distinguished from evacuation in that during an emergency phase there is the potential for a release, or a release exists; while in contrast, during the relocation phase, there is no passing plume.

Remedial Actions: Actions taken to restore a contaminated site to its precontaminated condition. In contrast to removal actions, remedial actions are longer-term actions and include cleanup, treatment, neutralization of contamination, and, if necessary, access control or permanent relocation of residents. Remedial actions are coordinated by the remedial project manager. DA Pamphlet 50-6, CAIRA Operations, treats remedial actions as taking place in a "non-emergency atmosphere," and describes their goal as returning the CAI site to "technically achievable and acceptable conditions."

Removal Actions: Immediate, short-term response actions for cleanup and removal of hazardous materials, assessment of the release, and actions to protect the public, such as temporary relocation (CERCLA and NCP; 40 CFR 300.65). Removal operations are coordinated by the on-site coordinator.

Response: Response activities are immediate actions taken to meet the demands of an emergency or disaster situation and are characterized by life-saving activities. Generally they are designed to provide emergency assistance for casualties. They also seek to reduce the probability of secondary damage and to speed recovery.

Restoration: Removal of rubble and emergency repair of structures and facilities, culminating in reestablishment of major utilities and services. In the present context, removal and decontamination of all chemical agents also would be included. Social and economic activities return to near-normal levels. The terms "recovery" and "restoration" have been used in combination to refer to the entire group of activities undertaken to prepare a previously contaminated and restricted zone (or area) for reoccupation and/or use.

Restricted Area or Zone: An area with controlled access from which the population has been evacuated or relocated; any area to which access is controlled for the protection of individuals from exposure to contamination from chemical agents.

Return: Refers to the reoccupation of areas cleared for unrestricted residence or use for previously evacuated populations. It includes what was termed "resettlement" in earlier draft EPA guidance.

Sarin: GB, methyl phosphonofluoridate isopropylester, a nonpersistent organophosphate nerve agent.

Soman: GD, O-pinacolyl methylphosphonofluoridate, a nerve agent.

Sulfur Mustard: H/HD, bis(2-chloroethyl) sulfide, a blister agent.

Tabun: GA, N,N-dimethyl phosphoramidocyanidate ethyl ester, a non-persistent organophosphate nerve agent.

Unitary Chemical Munitions: Munitions designed to contain a single-component chemical agent for release on a target.

5X: A level of decontamination in use by the Army. Level 5X is intended to render an object safe for release to the public without restriction according to Army regulations. An approved 5X method involves heating to 1000°F for a minimum of 15 minutes.

VX: S-(diisopropylaminoethyl) methyl phosphonothiolate o-ethyl ester, a persistent nerve agent.

APPENDIX B:

STATE ENVIRONMENTAL AUTHORITY AND AGENCY CONTACTS

Alabama

Alabama Department of Environmental Management
1751 Congressman W.L. Dickinson Drive
Montgomery, AL 36109
(205) 271-7700

Sara Title III
Emergency Management Agency
(800) 843-0699

Emergency Response Commission
c/o Emergency Management Agency
5898 County Road 41
Clanton, AL 35045-5160
(205) 280-2200
(800) 843-0699 (in-state 24-hour number)

RCRA Authority
Land Quality Division
Department of Environmental Management
P.O. Box 301463
1751 Congressman W.L. Dickinson Drive
Montgomery, AL 36130-1463
(205) 271-7726

Arkansas

Department of Pollution Control and Ecology
P.O. Box 8913
8001 National Dr.
Little Rock, AR 72219
(501) 562-7444

SARA Title III
Arkansas Office of Emergency Services
(501) 329-5601

RCRA Authority
Division of Hazardous Waste
Department of Pollution Control
8001 National Dr.
Little Rock, AR 72219
(501) 570-2872

Colorado

Colorado Department of Public Health and Environment
Office of Health
4300 Cherry Creek Drive South
Denver, CO 80222-1530
(303) 692-2100

SARA Title III
Colorado Emergency Planning & Community Right-to-Know Commission
Office of Emergency Management
Division of Disaster Emergency Services
Camp George West
1500 Golden Rd.
Golden, CO 80401
(303) 273-1624
(303) 377-6326 (in-state 24-hour number)

RCRA Authority
Colorado Department of Public Health and Environment
Hazardous Materials and Waste Management Division
4300 Cherry Creek Drive South
Denver, CO 80222-1530
(303) 692-3300

Illinois

Illinois Environmental Protection Agency
2200 Churchill Road
Springfield, IL 62706
(217) 782-3397

Illinois (Cont.)

SARA Title III
State Emergency Response Commission
c/o Supervisor, Hazardous Materials Programs
Illinois Emergency Management Agency
Hazardous Materials Section
110 East Adams St.
Springfield, IL 62706
(217) 782-4694
(800) 782-7860 (All spills, 24 hours, in state)
(217) 782-7860 (All spills, 24 hours)

RCRA Authority
Land Pollution Control Division
Illinois Environmental Protection Agency
Bureau of Land
2200 Churchill Road
Springfield, IL 62706
(217) 782-6762

Indiana

Department of Environmental Management
100 North Senate Ave.
Indianapolis, IN 46206-6015
(317) 232-8560

SARA Title III
Indiana Department of Environmental Management
P.O. Box 6015
100 North Senate Ave.
Indianapolis, IN 46206-6015
(317) 233-7745

RCRA Authority
Solid and Hazardous Waste Management Office
P.O. Box 6015
100 North Senate Ave.
Indianapolis, IN 46206-6015
(317) 232-3210

Kentucky

Natural Resources and Environmental Cabinet
Capital Plaza Tower, 5th Floor
Frankfort, KY 40601
(502) 564-3350

SARA Title III
State Emergency Operations Center
State Emergency Response Commission
Boone National Guard Center
Frankfort, KY 40601-6168
(502) 564-7815
Environmental Response Center
(502) 564-2380
(800) 928-2380

RCRA Authority
Department of Environmental Protection
14 Reilly Road
Frankfort, KY 40601
(502) 564-2150

Maryland

Maryland Department of the Environment
2500 Broening Highway
Baltimore, MD 21224
(410) 631-3000

SARA Title III
Maryland Department of the Environment
Hazardous Waste Program
2500 Broening Highway
Baltimore, MD 21224
(410) 631-3800

RCRA Authority
Hazardous Waste Program
Maryland Department of the Environment
2500 Broening Highway
Baltimore, MD 21224
(410) 631-3304

Oregon

Oregon Department of Environmental Quality
811 S.W. Sixth Ave.
Portland, OR 97204
(503) 229-5696

SARA Title III
State Emergency Response Commission
c/o State Fire Marshal's Office
Hazardous Materials Section
3000 Market Street Plaza
Salem, OR 97310
(503) 378-3473
DEQ Emergency Management Division
(800) 452-4011 (24-hour, in-state)
(503) 229-5412 (land hazardous waste)
(503) 229-5554 (air emissions)

RCRA Authority
Waste Management and Cleanup Division
Oregon Department of Environmental Quality
811 S.W. Sixth Ave.
Portland, OR 97204
(503) 229-5913

Utah

Utah Department of Environmental Quality
168 North 1950 West
Salt Lake City, UT 84116
(801) 536-4400

SARA Title III
Utah Department of Environmental Quality
Division of Environmental Response and Remediation
168 North 1950 West
Salt Lake City, UT 84116
(801) 536-4100
(801) 536-4123 (24-hour emergency number)

RCRA Authority
Solid and Hazardous Waste Section
Department of Environmental Quality
288 North 1460 West
Salt Lake City, UT 84116
(801) 538-6170

Washington

Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600
(206) 407-7012

SARA Title III
State Emergency Management Division
P.O. Box 48346
Olympia, WA 98504-8341
(206) 459-9191
(800) 258-5990 (24-hour)

RCRA Authority
Hazardous Waste and Toxics Reduction Division
Department of Ecology
P.O. Box 47600
Olympia, WA 98504-7600
(206) 407-6700

APPENDIX C:

EMERGENCY AND ENVIRONMENTAL INFORMATION HOTLINES

Information Source	Telephone Number
National Response Center Hotline	800-424-8802 202-426-2675
EPCRA/Superfund/ RCRA/Underground Storage Tank Hotline	800-535-0202 800-424-9346
EPA Public Information Center	202-260-2080
National Pesticides Telecommunications Network	800-858-7378
Hazardous Materials Information Exchange (HMIX)	
Technical assistance	800-752-6367
Ill. technical assistance	800-367-9592
Computer	708-252-3275 or FTS 708-252-3275
Toll-free computer	800-874-2884
Internet access	HMIX.DIS.ANL.GOV or 146.137.16.97
EPA Toxic Release Inventory Hotline	800-535-0202
EPA Safe Drinking Water Hotline	800-426-4791
EPA Hazardous Waste Disposal Hotline	800-438-4318
EPA Toxic Substances Control Act Hotline	202-382-5533
American Conference of Government Industrial Hygienists (ACGIH)	513-825-0312
CHEMTREC Emergency Hotline	800-424-9300
CMA CAER Information Line	800-624-4321
CHEMTREC Center Information Helpline	800-262-8200

Information Source	Telephone Number
Institute of Chemical Waste Management	202-659-4613
Environmental Industry Associations	202-659-4613
U.S. Department of Labor/Occupational Safety and Health Administration	202-219-8148